Office of Energy Efficiency

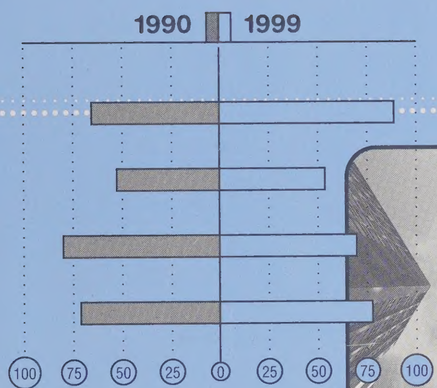
Energy Efficiency Trends in Canada 1990 to 1999

An Update

Indicators of Energy Use, Energy Efficiency and Emissions

July 2001

OEE



Trends 1990-1999

Natural Resources Canada
Ressources naturelles Canada

Office of Energy Efficiency
Office de l'efficacité énergétique

Canada

Energy Efficiency Trends in Canada 1990 to 1999 — An Update

Also published in French under the title: *Évolution de l'efficacité énergétique au Canada de 1990 à 1999 — Mise à jour*

Cat. no. M92-145/2001E
ISBN 0-662-30567-1

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Preface

This report is the sixth annual review of trends in energy use, energy efficiency and greenhouse gas (GHG) emissions in Canada, using 1990 as the baseline year. *Energy Efficiency Trends in Canada, 1990 to 1999* differs from the previous five reports in the following ways:

- it addresses the period from 1990 to 1999;
- it uses a number of improved data sources and analytical methodologies; and
- the analysis of the industrial sector is based on 53 industries, compared to 40 in last year's report.

As was the case with previous reports, the intent is to provide the reader with a detailed description of the framework, methodology and data sources used for the review. A database containing all energy indicators calculated for this report is available on the Internet by searching for *Energy Efficiency Trends in Canada* at: *http://oee1.NRCan.gc.ca/dpa/analysis_e/trends.cfm*

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Chapter 1 Scope of the Report

Highlights

- This report provides an updated overview of market trends in energy efficiency, energy use and associated greenhouse gas (GHG) emissions in the five major end-use sectors – residential, commercial, industrial, transportation and agriculture – over the period 1990 to 1999.
- As in previous reports, a factorization method is used to separate the principal factors influencing the change in energy use and related GHG emissions.
- The quality and quantity of data upon which the analysis is based vary greatly across sectors. Natural Resources Canada (NRCan) is continually improving the quality of the information used to understand the evolution of energy use in Canada. This report includes a number of improvements in data accuracy.

In December 1997 at the third Conference of the Parties (COP3) held in Kyoto, Japan, participating countries agreed to a timetable of GHG emissions reductions for the years 2008 to 2012 relative to 1990. Canada committed to reduce its emissions by 6 percent below 1990 levels. A key element of most countries' strategy to meet their reduction objective is to increase energy efficiency in all sectors of the economy. In Canada, governments at all levels have programs to reduce the market barriers to energy efficiency and to accelerate the development and adoption of more energy-efficient technologies.

In 2000, the *Government of Canada Action Plan 2000 on Climate Change* – the first in a series of Business Plans that Canada will undertake to deal with climate change – was put forward. *Action Plan 2000* focuses primarily on GHG emissions reductions and sets the stage for future measures. Improving energy efficiency is an integral part of *Action Plan 2000*.

The National Action Program on Climate Change (NAPCC) outlines the federal-provincial strategy for achieving emissions reductions. Under the NAPCC, Canada has committed to develop indicators of progress.[1] This report updates last year's *Energy Efficiency Trends in Canada 1990 to 1998*[2] and delivers on Canada's commitment to track market trends in energy efficiency and energy use and to understand its role in GHG emissions.

The rest of this chapter describes the relationship between energy efficiency, secondary energy use and GHG emissions, as well as the approach and the data used in this report to model these relationships. The remainder of the report describes the results of the analysis for total secondary energy followed by the results by sector.

1.1 The Approach

The objectives of this report are to:

- highlight the influence of the factors affecting energy use and GHG emissions; and
- explain the contribution of changes in energy efficiency to the evolution of secondary energy use and GHG emissions.

The analysis in this report deals mainly with secondary energy use and the resulting GHG emissions. Electricity is the only energy form for which the GHG emissions associated with its production are attributed to secondary energy use. The emissions from the mining component and petroleum refining component of energy production are defined as industrial energy use and are not attributed to the secondary use. In this report, end-use electricity has been attributed an emissions factor reflecting the average mix of fuels used to generate electricity in Canada.

1 Government of Canada, *Canada's National Action Program on Climate Change*, Ottawa, Ontario, 1995, Chapter 5

2 Natural Resources Canada, *Energy Efficiency Trends in Canada 1990 to 1998*, Ottawa, Ontario, 2000

GHG emissions originate from secondary energy combustion, non-combustion uses of energy (industrial processes), electricity generation, and oil and gas production. The relationship between secondary energy use and GHG emissions is illustrated in Figure 1.1.

At the secondary level, most energy is used in five end-use sectors to meet specific end uses such as space heating. The combustion of fossil fuels to meet these end uses produces GHG emissions. The level of emissions varies according to the quantity and type of fuel used. Total GHG emissions in Canada in 1999 are estimated to have been 706.9 megatonnes of CO_2 equivalent. Of this amount, 452.4 megatonnes, or 64.0 percent, occurred as a result of energy use at the secondary or end-use level.[3] This amount decreases to 352.4 megatonnes, or 49.9 percent, when electricity-related emissions are excluded.

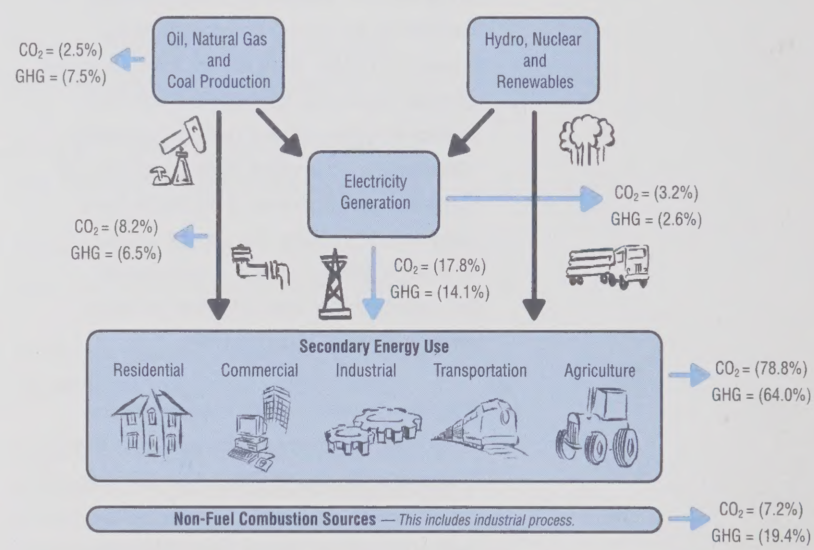
The principal objective of this report is to isolate and then relate trends in energy efficiency to trends in secondary energy use and, ultimately, to extend this relationship to trends in GHG emissions.

A factorization model is used to attribute the change in energy use to four factors: activity, structure, weather and energy efficiency. The definitions of activity and structure used in this report for each sector are described in Table 1.1. The factorization results will vary if different definitions of activity and structure are used.

Increases in sector activity lead to increased energy use and GHG emissions. In the residential sector, for example, if all other factors remained the same, an increase in the number of households would increase energy use in that sector.

A shift in the structure of activity toward more energy-intensive components of activity, all other things remaining constant, leads to increased energy use and emissions. For example, if the share of total industry activity held by forestry decreased while the iron and steel industry's share increased, total industrial energy use would increase, as the iron and steel industry is more energy intensive than the forestry industry.

Figure 1.1 The Relationship Between Secondary Energy Use and GHG Emissions



Note: Electricity-related GHG emissions are allocated to the end-use sectors in this figure.

3 From this point on in the report, any reference to emissions implies GHG emissions from secondary energy use.

Table 1.1 Definitions of Activity and Structure Used in This Report, by Sector

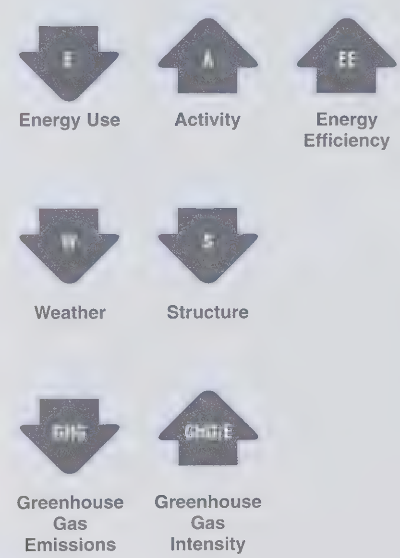
Sector	Activity	Structure
Residential	Number of households and floor area of houses (space conditioning)	End-use mix: (e.g., space heating, space cooling, appliances, lighting and water heating)
Commercial	Floor space	Building type (e.g., offices, retail stores and hotels/restaurants)
Industrial	Composite measure of activity based on GPD and, when available, physical units of production and gross output	Sector mix: (e.g., pulp, other manufacturing, iron and steel)
Transportation	Passenger-kilometres and tonne-kilometres	Mode mix: (e.g., road, rail, air and marine)
Agriculture	Gross domestic product	n.a.

Fluctuations in weather lead to changes in space heating and cooling requirements. A colder winter or a warmer summer can both lead to increased energy use. The weather effect is most significant in the residential and commercial sectors where both heating and cooling requirements account for a significant share of energy use.

Changes in energy efficiency (activity per unit of energy use) are approximated by changes in energy intensity (energy per unit of activity) adjusted for changes in structure, activity and weather. The trends in energy efficiency are calculated at several levels. For instance, in the case of the industrial sector, changes in energy efficiency are calculated at the industry level, the sector level and at the secondary energy level (i.e. all five sectors together).

It should be noted that estimates of energy efficiency in this report reflect factors other than "technical energy efficiency." Pure or technical energy efficiency can be measured only for an appliance or piece of equipment such as a refrigerator or a furnace. Therefore, even the most disaggregated energy efficiencies presented in this report may reflect factors beyond technical energy efficiency. In the industrial sector, for example, the most disaggregated energy efficiency presented here is an industry-specific efficiency that reflects a combination of technical energy efficiency and variations in the mix of products, processes, fuels and other factors for that industry.

Throughout this report barometers (a system of arrows) are used to depict the impact of various factors on energy use and GHG emissions. An arrow pointing upwards indicates that this factors contributed to an increase in energy use. Alternatively an arrow pointing downward indicates that this factor contributed to a decrease in energy consumption. Arrows are described as follows.



= is used to indicate that the sum of the changes in these factors approximates the change in energy use and GHG emissions.

Changes in energy efficiency are estimated for all five end-use sectors using the approach described above (these estimates are presented in Chapters 3 through 7). Variations in sectoral energy efficiency are aggregated into a single index of secondary energy efficiency called the OEE Energy Efficiency Index. This index, presented in Figure 1.2, shows an increase, which reflects an improvement in secondary energy efficiency of almost 1.0 percent per year between 1990 and 1999.

Figure 1.2 The OEE Energy Efficiency Index, 1990–1999 (index 1990 = 1.0)

The OEE Energy Efficiency Index provides a much better estimation of changes in energy efficiency than the more commonly used ratio of gross domestic product (GDP) per unit of secondary energy use. This ratio captures not only changes in energy efficiency but also changes in structure and weather.

Work continues to improve both the quality and the availability of energy data to ensure that the OEE Energy Efficiency Index continues to improve as an energy efficiency indicator.

Chapter 2 provides an analysis of secondary energy use-related GHG emissions trends. Chapters 3 to 7 describe the results of the sector-by-sector GHG emissions analysis. In each sector, GHG emissions are driven by two principal factors: energy use and the GHG intensity of this energy use. The sector-by-sector analysis elaborates on these principal factors and the impact that they, and energy efficiency, have on GHG emissions trends for each sector.

1.2 The Data

Good quality energy use, GHG emissions and activity level data for each end-use sector is crucial to the quality of the OEE's trends analysis. The strengths and weaknesses of the major data used in this report are discussed below, along with some data improvements that have been introduced since the last report.

Good quality energy use, GHG emissions and activity level data for each end-use sector is crucial to the quality of the OEE's trends analysis.

Activity

In the *residential sector*, activity is measured by the number of households in Canada and the total floor area of these dwellings.

In the *commercial sector*, the measure of activity is floor space, but little floor space data exist for Canada. Floor space is therefore estimated based on investment flows, demolition rates, capital expenditures by structure and asset type, and average construction cost data. This year, the OEE has undertaken Canada's first *Commercial Institutional Building Energy Use Survey* (CIBEUS) which will provide an estimate of commercial energy intensity in Canada.

Aggregate energy use data for each sector are extracted from the Statistics Canada's Quarterly Report on Energy Supply-Demand in Canada **(QRESD),** *Canada's official energy balance.*

In the *industrial sector*, activity is measured using a composite measure that uses GDP, gross output and physical units of production. When physical units are not available, estimates of gross output are used. Likewise, when gross output is not available, GDP alone is used. This measure has the desirable features of being summable across industries and reflective of growth in physical units of production. These data are compiled by the Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC) in support of the Canadian Industry Program for Energy Conservation (CIPEC).

In the *transportation sector*, which consists of both passenger and freight transportation, there are also data limitations. For the passenger transportation sub-sector, activity is defined in terms of passenger-kilometres, while freight activity is defined using tonne-kilometres. Unfortunately, only partial data are available for these measures. Passenger-kilometre data for air and rail travel are available from Statistics Canada. However, passenger-kilometre travel via light-duty vehicles and buses must be estimated from data on vehicle and bus stocks, average distances travelled[4] and vehicle occupancy rates. These data are available only for certain years, so time-series estimates have been developed for missing years. For freight transportation, Transport Canada provides tonne-kilometre data for marine freight activity, and Statistics Canada provides data for rail activity and partial data for trucking activity.

In the *agriculture sector*, activity is measured by the agricultural sector's contributions to GDP.

Energy Use

Aggregate energy use data for each sector are extracted from the Statistics Canada's *Quarterly Report on Energy Supply-Demand in Canada* (QRESD), Canada's official energy balance. These data are available by fuel type for each end-use sector. Energy use data throughout this report are presented in petajoules. One petajoule is equivalent to the energy requirement of about 10 000 houses in a year.

In the *residential sector*, energy demand estimates for each end use are derived through a calibration process that takes into account aggregate energy use and detailed data on the characteristics of buildings and household equipment.

A modelling approach is also used in the *commercial sector* to estimate end-use demand by building type. These end-use estimates are arrived at normatively through discussions with sector experts. Among the five end-use sectors, energy use data limitations are most significant for the commercial sector.

In the *industrial sector*, the QRESD data are supplemented by CIEEDAC's detailed energy use database to provide a breakdown of energy use in 53 industries (the QRESD data are broken down into 10 industrial sub-sectors). This has allowed for a more precise identification of changes in energy use patterns arising from structural changes in industry composition and has contributed greatly to an improved understanding of the factors underlying industrial energy use. These data improvements are possible because of the OEE's annual funding of the expansion of the *Industrial Consumption of Energy* (ICE) *Survey*.

4 These reflect the OEE's *National Private Vehicle Use Survey*. The survey was run quarterly from the fourth quarter of 1994 to the third quarter of 1996.

In the *transportation sector*, energy demand data for road, rail, aviation and marine transportation modes are available from the QRESD. A calibration process is then used to split energy demand into passenger and freight transportation.

In the *agriculture sector*, the QRESD supplies aggregate energy demand data by fuel type. A calibration process is then used to regroup the energy use data into motive and non-motive energy demand.

Greenhouse Gas Emissions

The GHG emissions data in this report are derived by multiplying energy use by GHG emission factors developed by Environment Canada.[5] This report includes data on the three principal combustion-related GHGs: carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Both N_2O and CH_4 emissions have been converted to CO_2 equivalents using their internationally recognized 100-year global warming potentials of 310 and 21 respectively.[6]

The sector-specific emissions reported here differ from those presented by Environment Canada. This is primarily due to differences in the sectoral definitions used by the OEE and Environment Canada (i.e. the QRESD energy data may be reallocated to different sectors by either organization).[7] As well, Environment Canada's estimates of wood fuel combustion in the residential sector exceed the OEE's estimates quoted in this report.

Energy Efficiency vs. Energy Intensity

Traditionally, energy intensity has referred to the ratio of the total amount of energy used by an entity (e.g. house, industry, transportation sector) over the total amount of activity (e.g. floor space, tonnes of steel, kilometres travelled per passenger) that the entity engaged in over a specified time period. In this report, this is referred to as aggregate energy intensity, and it is the total energy consumed by a sector divided by the total amount of activity in that sector over a one-year period.

Energy efficiency refers specifically to how much activity a specific technology can generate for a given amount of energy over a certain amount of time. When referring to technologies, the distinction between energy efficiency and energy intensity is insignificant – one is simply the inverse of the other. However, energy efficiency and intensity begin to diverge as the system being referred to becomes more complex. For instance, if the weather changes, the energy efficiency of the heating systems in the entire residential sector will not change, but the energy intensity of that home or the residential sector would change as it would require a different amount of energy to provide the same amount of activity. The analysis in this report does not attempt to measure energy efficiency directly. To do so, one would be required to measure the energy efficiency of every piece of equipment in every sector of the economy. What is measured instead are the changes in the ratio of the level of activity each end-use sector engages in to the energy that that sector consumes over a one-year period, net of the impact of changes in the weather and the structure of the economy. It approximates the change in the average energy efficiency of the equipment in each end-use sector.

5 Environment Canada, *Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends*, Ottawa, Ontario, April 1999

6 Ibid.

7 These differences are documented in Appendix C.

Chapter 2 Economy-wide Trends in End-Use Energy, Energy Efficiency and Emissions

Highlights

- Over the 1990 to 1999 period, secondary energy use (E) increased by 12.2 percent or 859.0 petajoules.
    - The growth in secondary energy use was influenced by changes in energy efficiency, activity, structure and weather. These four factors had the following impacts:
    - Energy efficiency (EE) improved by 8.0 percent over the 1990 to 1999 period. Had all other factors remained constant and only energy efficiency changed, secondary energy use would have decreased by 559.8 petajoules.
    - Activity (A) increased in all five secondary energy-using sectors. Had all other factors remained constant and only activity changed, secondary energy use would have increased by 1501.8 petajoules.
    - Changes in the structure (S) or changes in the mix of energy end uses contributed to increased energy use. Had all other factors remained constant and only the mix of activity changed, secondary energy use would have increased by 82.3 petajoules.
    - Warmer weather (W) in 1999 compared to 1990 contributed to a decrease in energy requirements. Had all other factors remained constant and only the weather changed, secondary energy use would have decreased by 38.8 petajoules.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 11.0 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
    - Had only energy use changed over the period, GHG emissions would have been 12.2 percent above 1990 levels.
    - The GHG intensity of secondary energy use (GHG/E) decreased by 1.1 percent, indicating a move toward a greater use of energy sources with a lower GHG content. This improvement helped offset the impact of increased energy use.
- Without the improvements in energy efficiency, secondary energy-related GHG emissions would have been 32.2 megatonnes higher in 1999 than they were, which would have made 1999 emissions 18.9 percent higher than 1990 levels.

The Barometers – Secondary Energy Use

The Energy Use Barometer

The Emissions Barometer
<u>Including</u> Electricity-related GHGs

The Emissions Barometer
<u>Excluding</u> Electricity-related GHGs

In 1999, secondary energy use accounted for 7875.4 petajoules, about 70 percent of the total energy requirement in Canada. At the secondary level, energy is consumed in five sectors: residential, commercial, industrial, transportation and agriculture. The industrial sector accounts for the largest share of secondary energy use (39.0%), followed by the transportation (28.7%), residential (17.0%), commercial (12.5%) and agriculture (2.9%) sectors.

Table 2.1 illustrates energy use and associated GHG emissions, by sector, in 1999. The industrial and transportation sectors account for the largest shares of GHG emissions from secondary energy use (33.3% and 35.7% respectively), followed by the residential (15.5%), the commercial (12.0%) and the agriculture sectors (3.6%). The share of total secondary energy use-related emissions from the transportation and agriculture sectors exceed their share of energy consumption because of the relatively GHG-intensive nature of the energy they use.

Table 2.1 Sectoral Energy Distribution and Associated GHG Emissions, 1999

Sector	Energy (petajoules)	Greenhouse Gas Emissions (megatonnes)
Residential	1335.0	69.9
Commercial	983.6	54.1
Industrial	3068.5	150.6
Transportation	2258.4	161.6
Passenger	1323.0	93.4
Freight	860.1	62.9
Off-Road	75.3	5.3
Agriculture	229.9	16.2
Total	7875.4	452.4

Figure 2.1 illustrates the trends in secondary energy efficiency (the OEE Energy Efficiency Index described in Chapter 1), energy use, aggregate energy intensity and activity from 1990 to 1999. Secondary energy use increased by 12.2 percent from 1990 to 1999 while activity (GDP) increased by 23.6 percent. Aggregate energy intensity (E/GDP) decreased by 9.2 percent while energy efficiency improved by 8.0 percent.

Figure 2.1 Secondary Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

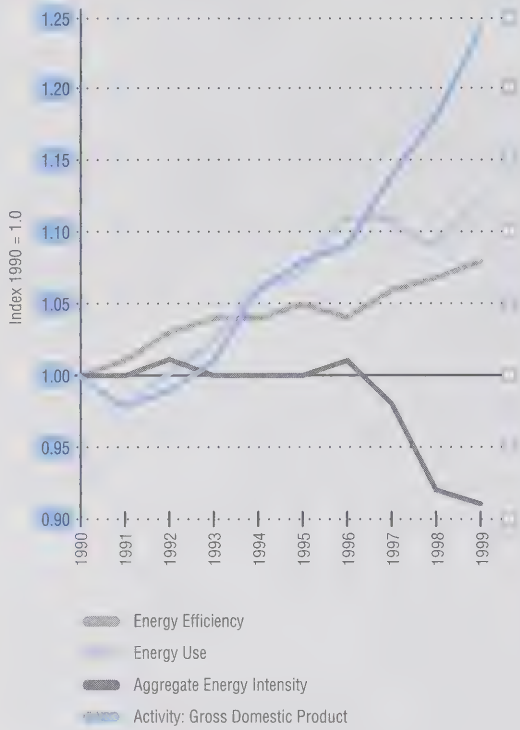


Table 2.2 presents the energy use for each sector and the major end uses or sub-sectors within each sector over time. As the table illustrates, energy use has increased in all sectors since 1990.

Secondary energy use increased by 12.2 percent from 1990 to 1999 while… energy efficiency improved by 8.0 percent.

Table 2.2 Energy Use by Sector, End Use and Sub-sector, 1990–1999 (petajoules)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Residential	**1317.6**	**1295.0**	**1325.4**	**1374.3**	**1403.2**	**1371.9**	**1468.2**	**1402.0**	**1288.7**	**1335.0**
Space Heating	810.5	794.6	824.1	858.2	871.4	846.5	922.6	866.8	754.1	791.0
Water Heating	261.8	258.4	261.5	270.1	280.4	274.9	290.6	284.3	279.9	287.7
Space Cooling	5.3	8.3	3.0	5.5	5.9	7.9	6.7	6.5	9.7	10.1
Appliances	186.8	181.0	182.8	186.9	190.1	187.2	190.9	187.0	187.7	187.2
White Goods	*132.4*	*128.4*	*128.5*	*125.5*	*125.7*	*122.3*	*123.6*	*119.3*	*118.0*	*116.3*
Others	*54.3*	*52.6*	*54.3*	*61.4*	*64.4*	*64.9*	*67.4*	*67.7*	*69.7*	*70.9*
Lighting	53.3	52.7	54.0	53.6	55.4	55.4	57.2	57.4	57.4	58.9
Commercial	**867.0**	**888.9**	**901.2**	**933.1**	**927.6**	**960.9**	**981.5**	**998.5**	**944.1**	**983.6**
Space Heating	446.7	454.8	473.6	489.1	477.2	494.5	515.5	517.4	460.3	491.2
Water Heating	68.7	69.7	73.0	71.7	74.8	79.1	72.0	77.6	77.7	77.7
Space Cooling	41.5	53.1	32.5	42.8	47.6	50.8	48.2	47.6	64.2	63.1
Auxiliary Equipment	64.3	65.2	66.6	68.8	69.9	72.0	72.2	75.3	70.4	72.4
Auxiliary Motors	110.1	111.0	115.8	118.4	117.1	121.0	125.6	128.5	118.9	124.4
Lighting	126.8	126.5	131.3	133.9	133.1	135.7	140.5	144.6	145.1	147.5
Street Lighting	8.9	8.7	8.4	8.3	8.0	7.8	7.5	7.4	7.5	7.3
Industrial	**2754.7**	**2701.0**	**2723.0**	**2748.0**	**2911.5**	**2973.5**	**3057.5**	**3057.2**	**3004.0**	**3068.5**
Mining	343.4	327.1	338.6	406.8	415.8	443.7	472.7	474.2	457.8	465.0
Pulp and Paper	784.7	779.2	780.1	782.7	866.1	871.4	874.6	882.9	884.2	941.3
Iron and Steel	219.4	235.0	244.9	241.9	250.3	247.9	252.3	251.4	254.7	259.0
Smelting and Refining	183.3	188.4	198.0	210.8	222.7	219.9	232.9	230.6	239.7	238.1
Cement	59.3	50.8	50.8	51.1	59.2	61.3	58.5	57.8	63.6	68.0
Chemicals	223.2	232.6	222.5	211.2	242.1	253.1	255.3	245.9	241.2	242.6
Petroleum Refining	334.9	314.0	321.5	325.0	317.3	308.4	329.5	320.9	291.9	289.4
Other Manufacturing	531.8	509.5	501.5	460.0	476.5	510.9	521.6	532.9	510.4	499.8
Forestry	7.7	6.5	7.4	7.9	7.5	7.9	9.6	11.1	12.3	14.8
Construction	66.9	57.9	57.6	50.7	54.0	48.9	50.5	49.5	48.0	50.4
Passenger Transportation	**1165.8**	**1113.8**	**1142.0**	**1152.3**	**1198.0**	**1212.3**	**1231.4**	**1247.1**	**1302.8**	**1323.0**
Light Vehicles*	903.6	871.7	892.0	914.6	949.2	952.2	953.0	964.6	1003.9	1018.2
Bus	69.7	71.4	74.0	68.9	71.4	70.4	66.5	65.6	70.1	65.0
Rail	5.1	3.3	3.2	3.4	2.9	2.4	2.5	2.3	2.2	2.3
Air	187.4	167.5	172.8	165.4	174.5	187.3	209.4	214.6	226.7	237.5
Freight Transportation	**658.6**	**637.2**	**649.7**	**661.3**	**709.6**	**730.5**	**748.1**	**803.3**	**821.7**	**860.1**
Trucks	467.7	447.0	456.6	481.6	519.3	550.3	571.6	625.3	628.1	665.2
Rail	84.4	79.6	83.5	83.0	86.4	78.5	76.6	77.9	74.4	78.8
Marine	106.5	110.6	109.7	96.8	103.9	101.7	99.9	100.1	119.2	116.2
Off-road	**53.4**	**56.2**	**58.4**	**59.5**	**60.2**	**62.2**	**63.5**	**66.7**	**69.9**	**75.3**
Agriculture	**199.2**	**195.2**	**196.9**	**198.8**	**195.8**	**209.2**	**222.9**	**230.0**	**224.7**	**229.9**
Total	**7016.4**	**6887.5**	**6996.6**	**7127.4**	**7405.9**	**7520.5**	**7773.1**	**7804.9**	**7656.0**	**7875.4**

* Light vehicles include passenger cars, light trucks and motorcycles.

Table 2.3 Factors Influencing Growth in Secondary Energy Use, 1990–1999 (petajoules)

Sector	Energy Use			A	S	W	EE	I	Other
	1990	1999	1999 less, '90 [5]						
Residential	1317.6	1335.0	17.3	240.9	16.9	-36.0	-171.8	-32.7	NA
Commercial [1]	867.0	983.6	116.6	136.0	1.3	-2.8	-13.4	-3.0	-1.6
Industrial	2754.7	3068.5	313.9	759.6	-74.2	NA	-251.6	-119.9	NA
Transportation	1877.9	2258.4	380.5	365.3	138.3	NA	-123.0	-11.5	11.4
Passenger [2]	1165.8	1323.0	157.2	150.0	46.6	NA	-44.1	15.1	-10.5
Freight	658.6	860.1	201.5	215.3	91.7	NA	-78.9	-26.6	0.0
Off-Road Motor Gasoline [3]	53.4	75.3	21.8	NA	NA	NA	NA	NA	21.8
Agriculture [4]	199.2	229.9	30.8	NA	NA	NA	NA	NA	30.8
Total	**7016.4**	**7875.4**	**859.0**	**1501.8**	**82.3**	**-38.8**	**-559.8**	**-167.1**	**40.6**

Terms:
A: Activity Effect, **S**: Structure Effect, **W**: Weather Effect, **EE**: Energy Efficiency Effect, **I**: Interaction Effect

(1) The factorization excludes street lighting. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(2) The factorization was done excluding the non-airline (commercial/institutional and public administration) air sector. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(3) The factorization analysis was not done for off-road motor gasoline. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(4) The factorization analysis was not done for the agricultural sector. Chapter 7 shows an aggregate analysis of the sector. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(5) The change in energy use between 1990 and 1999 shown in this column and the sum of the activity, structure, weather, energy efficiency and interaction for passenger and freight transportation are slightly different because of the exclusion from the factorization analysis of the non-commercial airlines in passenger transportation. The transportation sector differences are reflected at the secondary energy use level; other differences are excluded from the factorization such as agriculture, off-road motor gasoline and street lighting, which are included under "Other" column.

Table 2.3 presents the effect of changes in energy efficiency, activity, structure and weather on the growth in secondary energy use from 1990 to 1999. A fifth factor, the interaction effect, is also shown in Table 2.3. This factor results from the interaction among the other four factors (e.g. if energy efficiency improves and the activity level increases, there will be additional activity produced which requires less energy than was previously required).

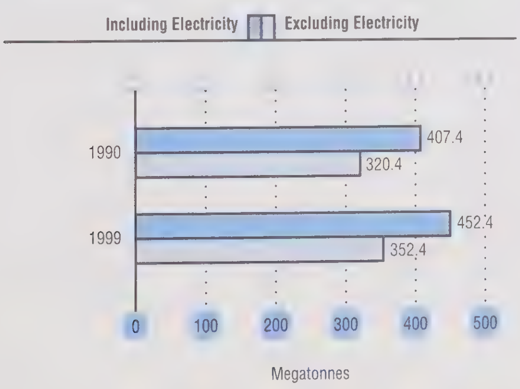
Growth in activity and structural changes within sectors toward more energy-intensive components contributed to an increase in secondary energy use of 1501.8 and 82.3 petajoules respectively. At the same time, energy efficiency improvements and a warmer winter in 1999 put downward pressure on secondary energy use of 559.8 petajoules and 38.8 petajoules from 1990 to 1999. Chapters 3 through 7 provide a short overview of sector-specific trends in energy use, energy efficiency, activity, structure and GHG emissions.

Table 2.4 Factors Influencing Secondary Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999

Sector	Greenhouse Gas Emissions (megatonnes)		Greenhouse Gas Emissions	Energy Use	Greenhouse Gas Intensity of Energy Use
			(percentage change)		
	1990	1999			
Residential	69.7	69.9	0.3	1.3	-1.0
Commercial	47.6	54.1	13.7	13.4	0.2
Industrial	141.3	150.6	6.6	11.4	-4.3
Transportation	135.1	161.6	19.6	20.3	-0.5
Agriculture	13.7	16.2	18.2	15.4	2.0
Total	**407.4**	**452.4**	**11.0**	**12.2**	**-1.1**

This year, GHG emissions are reported, both including and excluding GHGs generated at electrical power generation facilities for all sectors except the transportation sector (for which electricity is a relatively small portion of total energy consumption). This provides an indication of the magnitude and trends of both direct or "on-site" energy-related emissions and indirect energy-related emissions for each sector. Electricity-related emissions are calculated using an average emissions factor for all electricity produced in Canada. Figure 2.2 compares secondary energy-related GHG emissions with and without electricity-related emissions for 1990 and 1999.

Figure 2.2 Comparing Secondary Energy-related GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)



GHG emissions including electricity-related emissions were 27.2 percent and 28.4 percent higher than GHG emissions excluding electricity in 1990 and 1999 respectively.

Including Electricity-related GHG Emissions

Table 2.4 summarizes the changes in GHG emissions, secondary energy use and GHG intensity of energy use including electricity between 1990 and 1999 for the economy as a whole and for each end-use sector. Changes in GHG emissions are the result of changes in both the amount of energy used and in the GHG intensity of the fuel used.

GHG emissions resulting from secondary energy use in Canada increased by 11.0 percent between 1990 and 1999, from 407.4 megatonnes to 452.4 megatonnes. The main factor affecting the change in emissions was the growth in energy use. Across the economy, secondary energy use increased by 12.2 percent from 7016.4 petajoules to 7875.4 petajoules. The improvements in energy efficiency over the 1990 to 1999 period contributed to minimizing the increase in GHG emissions. Without the 8.0 percent improvement in energy efficiency, GHG emissions would have been 32.2 megatonnes higher in 1999 than actual levels.

The growth in emissions was offset by a 1.1 percent decrease in the GHG intensity of energy use. Had GHG intensity remained at 1990 levels, emissions would have been 4.7 megatonnes higher in 1999 than actual levels. The decrease in the GHG intensity was a result of shifts in the mix of fuels used to meet the growth in energy demand. Chapters 3 to 7 provide explanations of changes in the mix of fuels in each end-use sector.

Excluding Electricity-related GHG Emissions

Table 2.5 presents the secondary energy-related GHG emissions and intensity assuming that the electricity is GHG neutral to secondary energy users; that is, the GHG emissions associated with electricity generation are assigned to the generators of electricity and not the end users.

GHG emissions resulting from secondary energy use in Canada without GHG emissions associated with electricity generation increased by 10.0 percent between 1990 and 1999, from 320.4 megatonnes to 352.4 megatonnes. As previously mentioned, the main factor affecting the change in emissions was the growth in energy use. The improvements in energy efficiency over the 1990 to 1999 period contributed to minimizing the increase in GHG emissions. Without the 8.0 percent improvement in energy efficiency, GHG emissions excluding electricity-related emissions would have been 25.0 megatonnes higher in 1999 than actual levels.

The growth in emissions was offset by a 2.0 percent decrease in the GHG intensity of energy use. Had GHG intensity remained at 1990 levels, emissions would have been 7.2 megatonnes higher in 1999 than actual levels. The decrease in the GHG intensity was a result of shifts in the mix of fuels used to meet the growth in energy demand.

Table 2.5 Factors Influencing Secondary Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999

Sector	Greenhouse Gas Emissions (megatonnes)		Greenhouse Gas Emissions (percentage change)	Energy Use (percentage change)	Greenhouse Gas Intensity of Energy Use (percentage change)
	1990	1999			
Residential	43.5	42.5	-2.3	1.3	-3.6
Commercial	25.7	28.8	12.1	13.4	-1.3
Industrial	104.3	105.5	1.2	11.4	-9.2
Transportation	134.9	161.4	19.6	20.3	-0.5
Agriculture	12.0	14.2	18.3	15.4	2.3
Total	**320.4**	**352.4**	**10.0**	**12.2**	**-2.0**

Chapter 3 Residential Sector

Definition: The residential sector in Canada includes four major types of dwellings: single-detached homes, single-attached homes, apartments and mobile homes. Energy is used primarily for space and water heating, the operation of appliances, lighting and space cooling.

Highlights

- Over the 1990 to 1999 period, residential energy use (E) increased by 1.3 percent or 17.3 petajoules.
- The growth in residential sector energy use was influenced by changes in energy efficiency, activity, structure and weather. These four factors had the following impacts:
  - Energy efficiency (EE) improved by 13.0 percent over the 1990 to 1999 period. Had all other factors remained constant and only energy efficiency changed, residential energy use would have decreased by 171.8 petajoules.
  - Residential activity (A) increased by 18.3 percent. Had all other factors remained constant and only activity changed, residential energy use would have increased by 240.9 petajoules.
  - Changes in structure (S), or changes in the mix of energy end uses increased energy use. Had all other factors remained constant and only the mix of activity changed, residential energy use would have increased by 16.9 petajoules.
  - Warmer weather (W) in 1999 compared to 1990 contributed to a lower demand for space heating requirements than otherwise would have occurred. Had all other factors remained constant and only the weather changed, residential sector energy use would have decreased by 36.0 petajoules.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 0.3 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
  - Had only energy use changed over the period, GHG emissions would have been 1.3 percent above 1990 levels.
  - The GHG intensity of residential energy use (GHG/E) decreased by 1.0 percent, indicating a move toward a greater use of energy sources with a lower GHG content. This improvement helped offset the impact of increased energy use.
- Without the improvements in energy efficiency, residential GHG emissions (including electricity-related emissions) would have been [illegible] megatonnes higher in 1999 than they were, which would have made 1999 emissions 13.2 percent higher than 1990 levels.

The Barometers – Residential Sector

The Energy Use Barometer

The Emissions Barometer
Including Electricity-related GHGs

The Emissions Barometer
Excluding Electricity-related GHGs

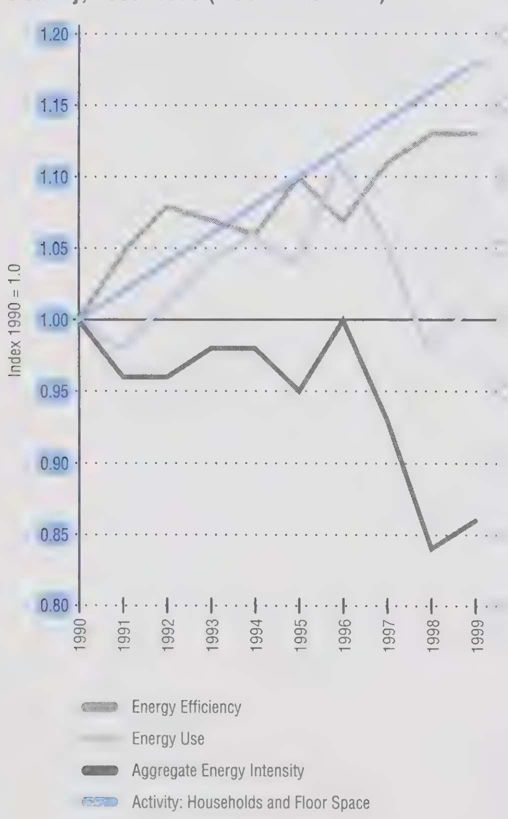
Residential energy use in 1999 was 1335.0 petajoules, accounting for 17.0 percent of secondary energy demand in Canada. GHG emissions from residential energy use totalled 69.9 megatonnes of carbon dioxide (CO_2) equivalent, or about 15.5 percent of GHG emissions from secondary energy use. Of this amount, 67.6 megatonnes (about 96.7 percent) were emissions of CO_2 while the remaining 3.3 percent were emissions of methane (CH_4) and nitrous oxide (N_2O).

Natural gas, used mainly for space heating and water heating, accounts for 45.6 percent of total residential energy demand, while electricity, oil and wood account for 35.7 percent, 9.8 percent and 8.0 percent respectively. The remaining energy demand is accounted for by coal and propane.

3.1 Evolution of Residential Energy Use and Its Major Determinants

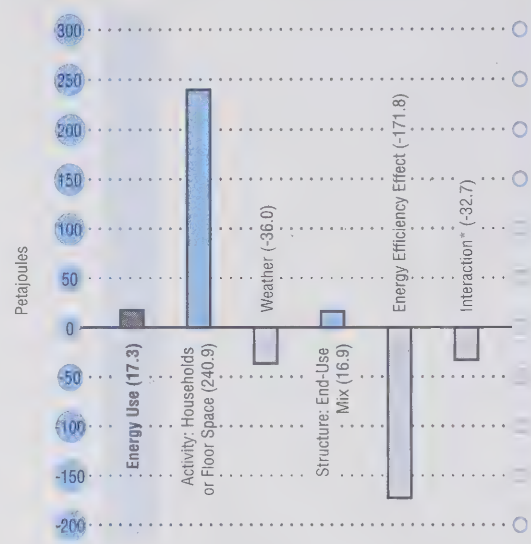
Figure 3.1 depicts the trends in total residential energy efficiency, energy use, aggregate energy intensity and activity from 1990 to 1999. Over this period, energy use increased by 1.3 percent while activity increased by 18.3 percent. Aggregate energy intensity (the weighted average of aggregate intensity for household services and space conditioning services) in the residential sector decreased by 14.3 percent during the 1990 to 1999 period while energy efficiency improved by 13.0 percent. The discrepancy between energy efficiency and aggregate energy intensity arises because aggregate energy intensity captures the changes in energy efficiency, structure and weather.

Figure 3.1 Residential Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)



Changes in residential energy use are attributed to four factors: changes in energy efficiency, changes in activity, changes in structure (changes in the mix of end uses) and changes in weather. The results of the factorization analysis for the residential sector are shown in Figure 3.2.

Figure 3.2 Factors Influencing Growth in Residential Energy Use, 1990–1999 (petajoules)



* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Residential energy use rose by 17.3 petajoules between 1990 and 1999. The level of activity[8] had the largest impact on energy use (increase of 240.9 petajoules). Over the 1990 to 1999 period, approximately 1.6 million new households were created in Canada, while floor space increased by 246.6 million square metres.

Over the 1990 to 1999 period, approximately 1.6 million new households were created in Canada...

8 This is measured using an index derived from the number of Canadian households and the floor area of dwellings. See *Energy Efficiency Trends in Canada 1990 to 1998* for more details.

The warmer 1999 heating season relative to the 1990 heating season resulted in a decrease in energy demand for space heating.

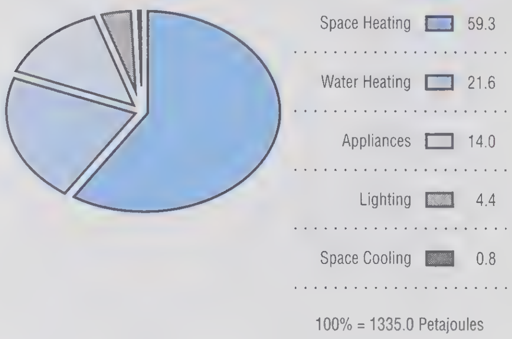
Weather is also a major determinant of the variations in household energy use. The winter of 1999, although colder than 1998 (the warmest year of the last decade), was warmer than the winter of 1990. The warmer 1999 heating season relative to the 1990 heating season resulted in a decrease in energy demand for space heating (36.0 petajoules). Heating degree-days were about 181 degree-days lower in 1999, a decrease of about 4.4 percent compared to 1990.

The structure (end-use mix) of residential energy use also changed between 1990 and 1999, contributing to an increase in residential energy use (16.9 petajoules). This is explained in large part by the fact that households own more appliances than before, and that these appliances tend to be larger.

Other than the change in the weather, the only other factor that offset the increase in residential energy use was the change in energy efficiency (decrease of 171.8 petajoules). The improvement in energy efficiency was a result of improved thermal efficiency of new and existing housing and efficiency gains in residential space heating equipment and appliances. It is important to note that this measure of energy efficiency is still influenced by factors other than energy efficiency. For example, variations of the occupational density of homes can have a significant impact on energy consumption.

There are five main end uses of energy in the residential sector: space heating, appliances, water heating, lighting and space cooling. Figure 3.3 shows the distribution of energy use among these end uses. In 1999, 80.8 percent of energy consumed in the residential sector was used for space and water heating, the largest energy end uses in this sector.

Figure 3.3 Distribution of Residential Energy Use by End Use, 1999 (percent)

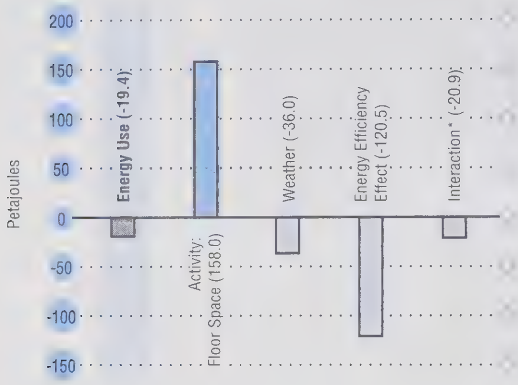


The energy used for space heating and by appliances is decomposed below to demonstrate the impact of changes in energy efficiency, activity, structure and weather on residential end uses.

Space Heating

From 1990 to 1999, energy demand for space heating decreased by 19.4 petajoules (see Figure 3.4). This decrease can be largely attributed to the energy efficiency improvements in the stock of heating systems and to improvements to the thermal envelopes of the Canadian housing stock. It is worth noting that this decrease in energy use occurred despite growth of the total amount of residential floor space. Warmer weather also contributed to a decrease in space heating energy use of 36.0 petajoules between 1990 and 1999.

Figure 3.4 Factors Influencing Growth in Residential Space Heating Energy Use, 1990–1999 (petajoules)



* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

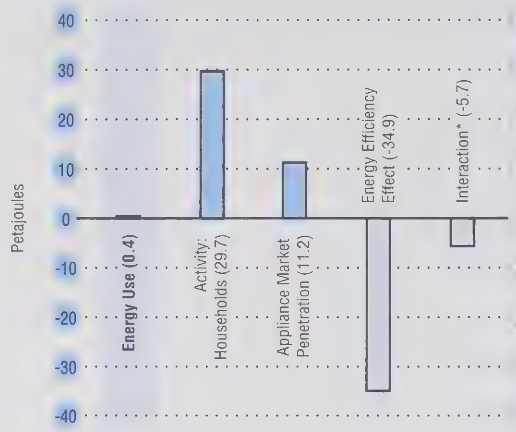
Figure 3.4 shows that the improvement in energy efficiency is largely responsible for the decrease in space heating energy use. Had all factors affecting space heating energy use remained constant except energy efficiency, space heating energy use would have decreased by 120.5 petajoules (14.9%) from 1990 to 1999.

While energy efficiency gains have been made because new homes tend to be better insulated with more efficient heating equipment and existing homes are often renovated over time, some of these gains are offset because newer homes are likely to be larger than those built in the past.

Appliances

Energy use by appliances increased by 0.4 petajoule from 1990 to 1999. Figure 3.5 shows the factors that influenced this increase.

Figure 3.5 Factors Influencing Growth in Residential Appliance Energy Use, 1990–1999 (petajoules)



* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

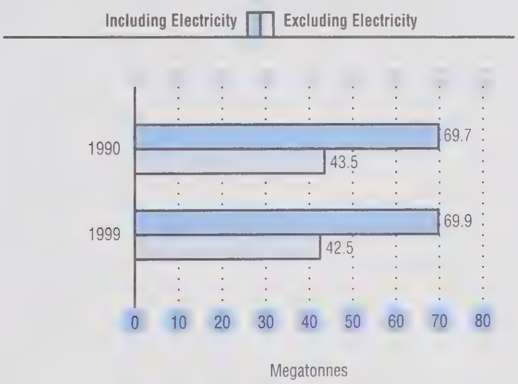
Figure 3.5 demonstrates that the increase in appliance energy use is a result of both increases in activity (increase of 29.7 petajoules) and a change in the mix of appliances (increase of 11.2 petajoules), due in part to the increased market penetration of some appliances such as dishwashers. These energy use increases associated with appliances were almost completely offset by substantial improvements in their energy efficiency (decrease of 34.9 petajoules).

... energy use increases associated with appliances were almost completely offset by substantial improvements in their energy efficiency.

3.2 Trends in Greenhouse Gas Emissions from Residential Energy Use

This year, GHG emissions are reported both including and excluding GHGs generated at electrical power generation facilities. This provides an indication of the magnitude and trends of both direct or "on-site" energy-related emissions and indirect energy-related emissions for each sector. Electricity-related emissions are calculated using an average emissions factor for all electricity produced in Canada. Figure 3.6 compares residential GHG emissions with and without electricity-related emissions for 1990 and 1999.

Figure 3.6 Comparing Residential GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

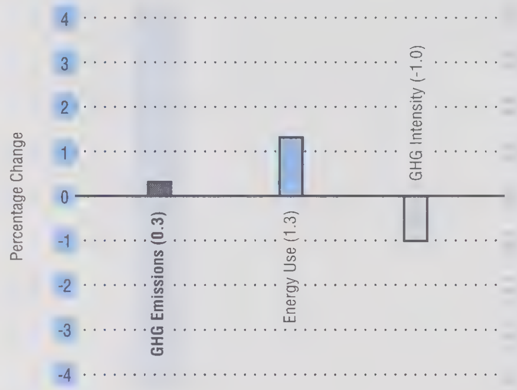


GHG emissions including electricity-related emissions were 60.2 and 64.5 percent higher than GHG emissions excluding electricity in 1990 and 1999 respectively.

Including Electricity-related GHG Emissions

Figure 3.7 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period including electricity-related emissions.

Figure 3.7 Factors Influencing Residential Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)



The 1.0 percent decline in the GHG intensity of residential energy use from 1990 to 1999 contributed to limiting the growth in GHG emissions to 0.3 percent. Without this decline in GHG intensity, emissions would have increased by 1.3 percent, or an additional 0.7 megatonne.

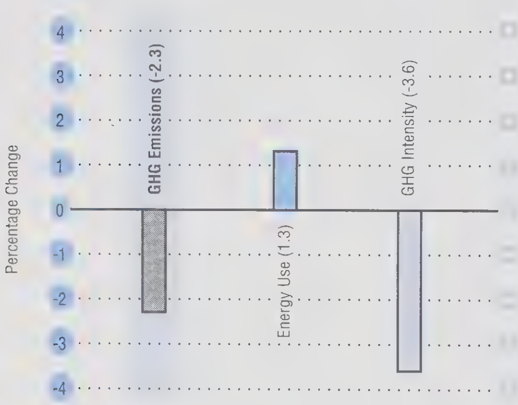
The downward trend in GHG intensity was due to changes in the mix of fuels used. Over the 1990 to 1999 period, natural gas's share of total residential energy use increased from 40.1 to 45.6 percent. This increase was to the detriment of heating oil, which saw its share decrease from 14.1 to 9.8 percent. Electricity's share of energy use in the sector remained almost stable over the period, at 35.5 percent in 1990 and 35.7 percent in 1999, although the GHG intensity of electricity increased over the review period. If the change in the mix of fuels had not occurred, residential GHG emissions from energy use would have been 1.2 megatonnes higher than actual levels.

The improvements in energy efficiency over the 1990 to 1999 period also contributed significantly to minimizing the increase in GHG emissions. Without the 13.0 percent improvement in energy efficiency, GHG emissions would have been 9.0 megatonnes higher in 1999 than they were, which would have made total 1999 residential energy-related emissions 13.2 percent higher than 1990 levels.

Excluding Electricity-related GHG Emissions

Residential GHG emissions excluding electricity-related emissions were 43.5 megatonnes in 1990 and decreased to 42.5 megatonnes by 1999. Figure 3.8 summarizes the change in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period excluding electricity-related emissions.

Figure 3.8 Factors Influencing Residential Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)



The 3.6 percent decline in the GHG intensity of residential energy use from 1990 to 1999 contributed to a decline of 2.3 percent in GHG emissions. Without this decline in GHG intensity, emissions would have increased by 1.3 percent.

The improvements in energy efficiency over the 1990 to 1999 period also significantly contributed to minimizing the increase in GHG emissions. Without the 13.0 percent improvement in energy efficiency, GHG emissions would have been 5.5 megatonnes higher in 1999 than they were, which would have made total 1999 residential energy-related emissions 10.3 percent higher than 1990 levels.

Chapter 4 Commercial Sector

Definition: The commercial sector in Canada includes activities related to trade, finance, real estate services, public administration, education and commercial services (including tourism). These activities are related to the floor space of nine different building types.

Street lighting, although included in total commercial energy use, is not included in the factorization analysis as it does not relate to floor space activity.

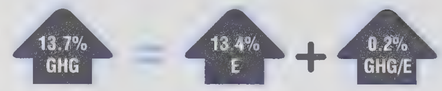
Highlights

- Over the 1990 to 1999 period, commercial energy use (E) increased by 13.4 percent, or 116.6 petajoules.
- The growth in commercial energy use was influenced by changes in energy efficiency, activity, structure and weather. These four factors had the following impacts:
  - Energy efficiency (EE) improved by 1.6 percent over the 1990 to 1999 period. Had all other factors remained constant and only energy efficiency changed, commercial energy use would have decreased by 13.4 petajoules.
  - Commercial activity (A) increased by 15.9 percent. Had all other factors remained constant and only activity changed, commercial energy use would have increased by 136.0 petajoules.
  - Changes in the structure (S) or changes in the mix of building types increased energy use. Had all other factors remained constant and only the mix of activity changed, commercial energy use would have increased by 1.3 petajoules.
  - Warmer weather (W) in 1999 compared to 1990 contributed to a lower demand for space heating requirements than otherwise would have occurred. Had all other factors remained constant and only weather changed, commercial energy use would have decreased by 2.8 petajoules.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 13.7 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
  - Had only energy use changed over the period, GHG emissions would have been 13.4 percent above 1990 levels.
  - The GHG intensity of commercial energy use (GHG/E) increased by 0.2 percent over the period, indicating the use of energy sources with a higher GHG content.
- Without the improvements in energy efficiency, commercial GHG emissions including electricity-related emissions would have been 0.7 megatonne higher in 1999 than they were, which would have made 1999 emissions 15.2 percent higher than 1990 levels.

The Barometers – Commercial Sector

The Energy Use Barometer

The Emissions Barometer
<u>Including</u> Electricity-related GHGs

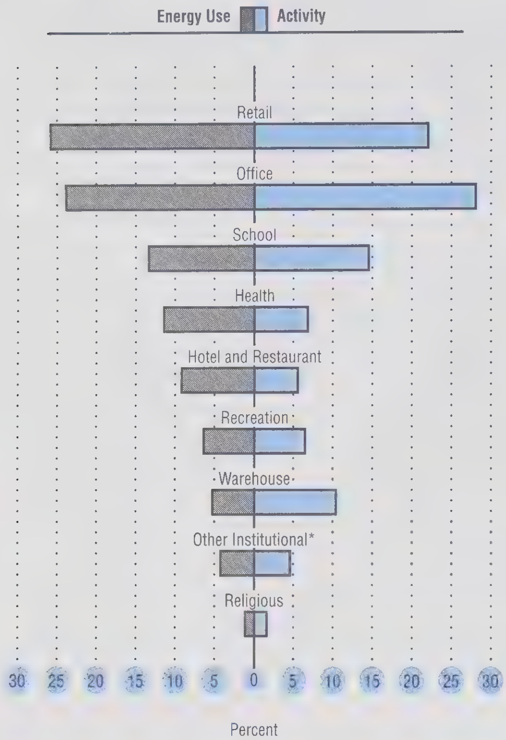


The Emissions Barometer
<u>Excluding</u> Electricity-related GHGs

Commercial energy use in 1999 was 983.6 petajoules, accounting for 12.5 percent of secondary energy demand in Canada. GHG emissions from commercial energy use totalled 54.1 megatonnes of carbon dioxide (CO_2) equivalent, or about 12.0 percent of GHG emissions from secondary energy use. Commercial-related GHG emissions were composed almost entirely of CO_2. In fact, 99.4 percent of the 1999 commercial GHG emissions were CO_2. The remaining 0.6 percent were emissions of methane (CH_4) and nitrous oxide (N_2O).

Natural gas, used mainly for space heating and water heating, accounts for 45.3 percent of total commercial energy demand, while electricity and oil account for 44.7 percent and 6.5 percent respectively. The remaining energy demand is accounted for by propane and steam.

Figure 4.1 Distribution of Commercial Energy Use and Activity by Building Type, 1999 (percent)



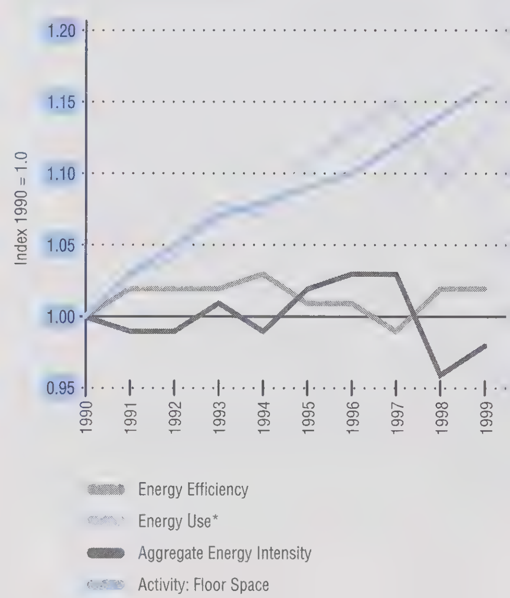
* Laboratory, research centre, library, museum.

The distribution of commercial energy use and activity by building type for 1999 is presented in Figure 4.1. About 70 percent of commercial energy use and floor space is accounted for by retail, office, educational and health buildings. For health facilities, hotels/restaurants and retail establishments, their share of energy use is larger than their share of total floor space, reflecting the energy-intensive nature of these sectors. In contrast, warehouses require minimal energy-related services relative to their floor space.

4.1 Evolution of Commercial Energy Use and Its Major Determinants

Figure 4.2 depicts the trends in total commercial energy use, energy efficiency, activity and aggregate energy intensity from 1990 to 1999. Over this period, energy use increased by 13.4 percent while activity increased by 15.9 percent. Aggregate energy intensity (total energy to floor space ratio) in the commercial sector decreased by 1.8 percent between 1990 and 1999 while energy efficiency improved by 1.6 percent. The discrepancy between energy efficiency and aggregate energy intensity arises because aggregate energy intensity captures the changes in energy efficiency, structure and weather.

Figure 4.2 Commercial Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

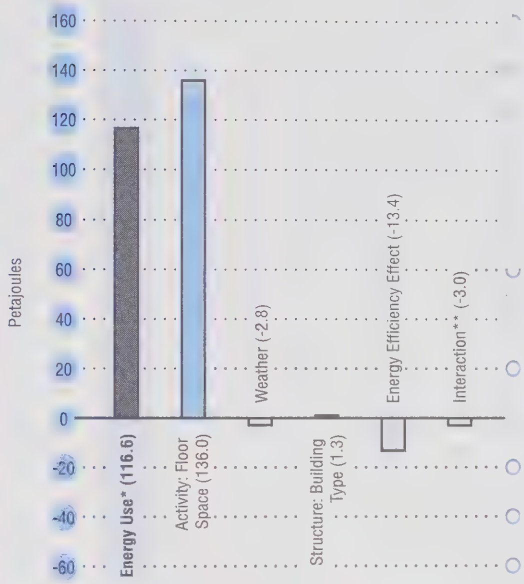


*Energy use includes street lighting but the factorization excludes street lighting.

Over the 1990 to 1999 period, approximately 74 million square metres of additional commercial floor space was constructed in Canada.

Changes in commercial energy use are attributed to four factors: changes in energy efficiency, changes in activity, changes in structure (changes in the mix of building types) and changes in weather. The results of the factorization analysis for the commercial sector are shown in Figure 4.3.

Figure 4.3 Factors Influencing Growth in Commercial Energy Use, 1990–1999 (petajoules)



* Energy use includes street lighting but the factorization excludes street lighting.

** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Commercial energy use rose by 116.6 petajoules between 1990 and 1999. The level of activity (measured by floor space) had the largest impact on energy use (increase of 136.0 petajoules). Over the 1990 to 1999 period, approximately 74 million square metres of additional commercial floor space was constructed in Canada.

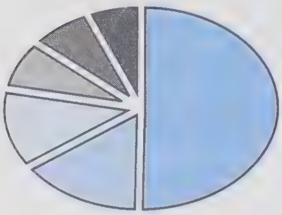
Weather is also a major determinant of the variations in commercial energy use. The winter of 1999, although colder than 1998 (the warmest year of the last decade), was warmer than the winter of 1990. The warmer 1999 heating season relative to the 1990 heating season and the warmer cooling season contributed to a decline in energy demand (2.8 petajoules). This contributed to a decline in energy demand because the decrease in energy demand for space heating was larger than the increase in demand for space cooling. Heating degree-days were about 181 degree-days lower in 1999, a decrease of about 4.4 percent compared to 1990, while cooling degree-days were about 69 degree-days higher in 1999, an increase of about 33.7 percent compared to 1990.

The structure (activity mix or mix of building types) of commercial energy use also changed between 1990 and 1999, leading to an increase in commercial energy use (1.3 petajoules).

The only factor other than weather offsetting the increase in commercial energy use was the change in energy efficiency (decrease of 13.4 petajoules). It is important to note that this measure of energy efficiency is still influenced by factors other than energy efficiency. For example, variations in the occupational density of buildings can have a significant impact on energy consumption.

There are six main end uses of energy in the commercial sector: space heating, auxiliary motors, auxiliary equipment, water heating, lighting (excluding street lighting) and space cooling. Figure 4.4 shows the distribution of energy use among these end uses. In 1999, 50.3 percent of energy consumed in the commercial sector was used for space heating, the largest energy end use in this sector.

Figure 4.4 Distribution of Commercial Energy Use by End Use, 1999 (percent)

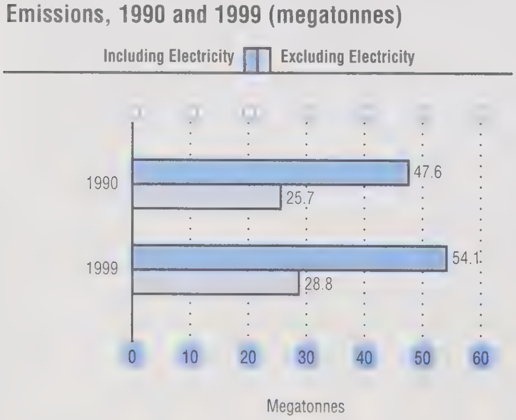


*Energy use excludes street lighting.

4.2 Trends in Greenhouse Gas Emissions from Commercial Energy Use

This year, GHG emissions are reported both including and excluding GHGs generated at electrical power generation facilities. This provides an indication of the magnitude and trends of both direct or "on-site" energy-related emissions and indirect energy-related emissions for each sector. Electricity-related emissions are calculated using an average emissions factor for all electricity produced in Canada. Figure 4.5 compares commercial GHG emissions with and without electricity-related emissions for 1990 and 1999.

Figure 4.5 Comparing Commercial GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

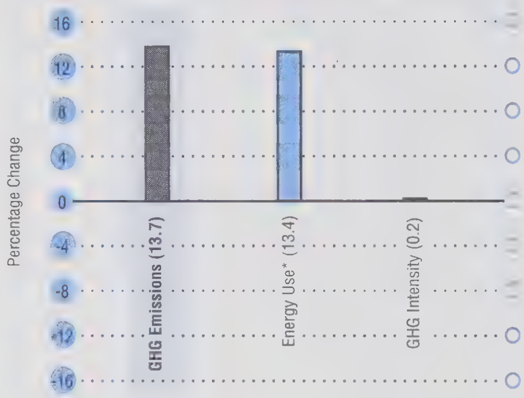


GHG emissions including electricity-related emissions were 85.2 and 87.8 percent higher than GHG emissions excluding electricity in 1990 and 1999 respectively.

Including Electricity-related GHG Emissions

Figure 4.6 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period including electricity-related emissions.

Figure 4.6 Factors Influencing Commercial Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)



* Energy use includes street lighting.

Without the 1.6 percent improvement in energy efficiency, GHG emissions would have been 0.7 megatonne higher in 1999 than they were.

The 0.2 percent growth in the GHG intensity of commercial energy use from 1990 to 1999 contributed to the 13.7 percent growth in GHG emissions. Without this growth in GHG intensity, emissions would have increased by only 13.4 percent.

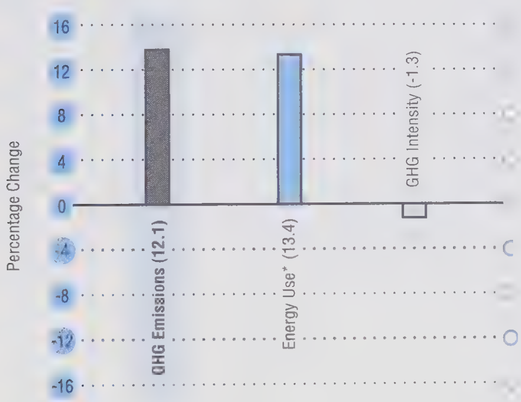
The increase in GHG intensity of commercial energy use was mainly due to an increase in the GHG intensity of electricity. Although there were some relatively minor changes in the mix of fuels used toward relatively less GHG-intensive fuels, the increase in the GHG intensity of electricity and its relatively large share of total energy use (44.7%) more than offset these changes.

The improvements in energy efficiency over the 1990 to 1999 period also contributed to minimizing the increase in GHG emissions. Without the 1.6 percent improvement in energy efficiency, GHG emissions would have been 0.7 megatonne higher in 1999 than they were, which would have made total 1999 commercial energy-related emissions 15.2 percent higher than 1990 levels.

Excluding Electricity-related GHG Emissions

Commercial GHG emissions excluding electricity-related emissions were 25.7 megatonnes in 1990 and increased to 28.8 megatonnes by 1999. Figure 4.7 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period excluding electricity-related emissions.

Figure 4.7 Factors Influencing Commercial Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)



* Energy use includes street lighting.

The 1.3 percent decline in the GHG intensity of commercial energy use from 1990 to 1999 contributed to limiting the growth in GHG emissions to 12.1 percent. Without this decline in GHG intensity, emissions would have increased by 13.4 percent, or an additional 3.5 megatonnes.

The improvements in energy efficiency over the 1990 to 1999 period contributed to minimizing the increase in GHG emissions. Without the 1.6 percent improvement in energy efficiency, GHG emissions excluding electricity-related emissions would have been 0.8 megatonne higher in 1999 than they were, which would have made total 1999 commercial energy-related emissions 15.0 percent higher than 1990 levels.

Chapter 5 Industrial Sector

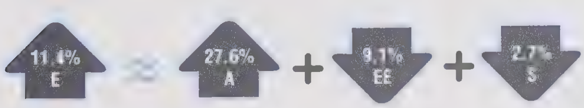
Definition: The Canadian industrial sector includes all manufacturing industries, metal and non-metal mining, upstream oil and gas, forestry and construction.

Highlights

- Over the 1990 to 1999 period, industrial energy use (E) increased by 11.4 percent, or 313.9 petajoules.
- The growth in industrial energy use was influenced by changes in energy efficiency, activity and structure. These three factors had the following impacts:
  - Energy efficiency (EE) improved by 9.1 percent over the 1990 to 1999 period. Had all other factors remained constant and only energy efficiency changed, industrial energy use would have decreased by 251.6 petajoules.
  - Industrial activity (A) increased by 27.6 percent. Had all other factors remained constant and only industrial activity changed, industrial energy use would have increased by 759.6 petajoules. The resulting increase in energy use offset the impact of both energy efficiency and structural change.
  - Changes in structure (S), specifically a change in the mix of activity toward less energy-intensive industries, brought about a decrease in energy use from what it would have been otherwise. Had all other factors remained constant and only the mix of activity changed, industrial energy use would have decreased by 74.2 petajoules.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 6.6 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
  - Had only energy use changed over the period, GHG emissions would have been 11.4 percent above 1990 levels.
  - The GHG intensity of industrial energy use (GHG/E) decreased by 4.3 percent, as industry moved toward a greater use of energy sources with a lower GHG content. This improvement helped offset the impact of increased energy use.
- Without the improvements in energy efficiency, industrial GHG emissions, including electricity-related emissions, would have been 12.4 megatonnes higher in 1999 than they were, which would have made 1999 emissions 15.4 percent higher than 1990 levels.

The Barometers – Industrial Sector

The Energy Use Barometer



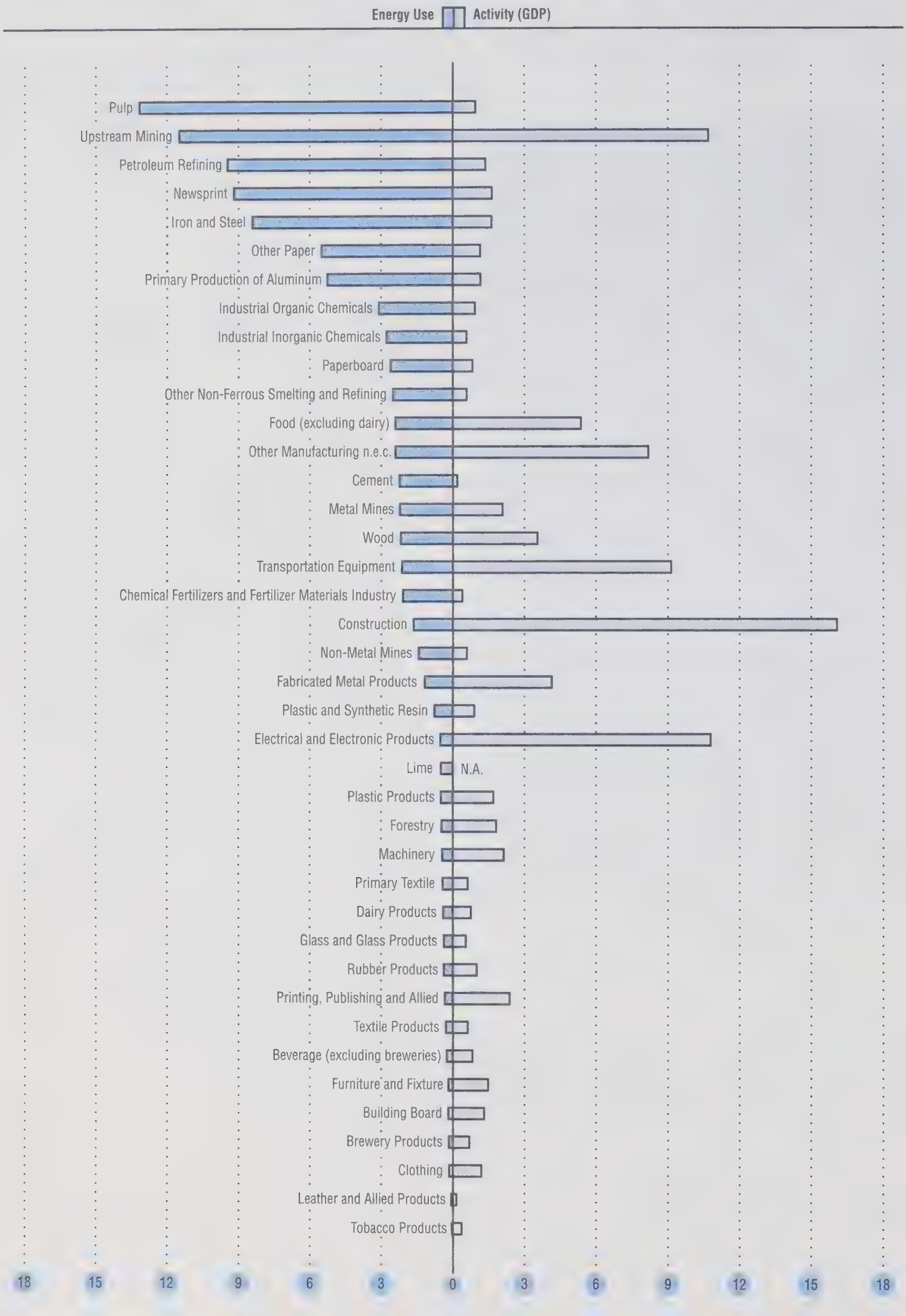
The Emissions Barometer
Including Electricity-related GHGs

The Emissions Barometer
Excluding Electricity-related GHGs

Industrial energy use in 1999 was 3068.5 petajoules, accounting for 39.0 percent of secondary energy demand in Canada. GHG emissions from industrial energy use totalled 150.6 megatonnes of carbon dioxide (CO_2) equivalent, or about 33.3 percent of GHG emissions from secondary energy use. Of this amount, 148.9 megatonnes (about 98.9%) were emissions of CO_2 while the remaining 1.1 percent were emissions of methane (CH_4) and nitrous oxide (N_2O).

Figure 5.1 shows that the pulp, newsprint, petroleum refining, and iron and steel industries accounted for a much larger share of energy (40.3%) than their share of industrial activity (5.5%). Conversely, the electrical and electronic products, construction, transportation equipment industries and other manufacturing industries accounted for a large share of industrial activity (44.2%) compared to their share of energy use (6.7%).

Figure 5.1 Distribution of Energy Use and Activity (GDP) by Industrial Sub-sector, 1999 (percent)



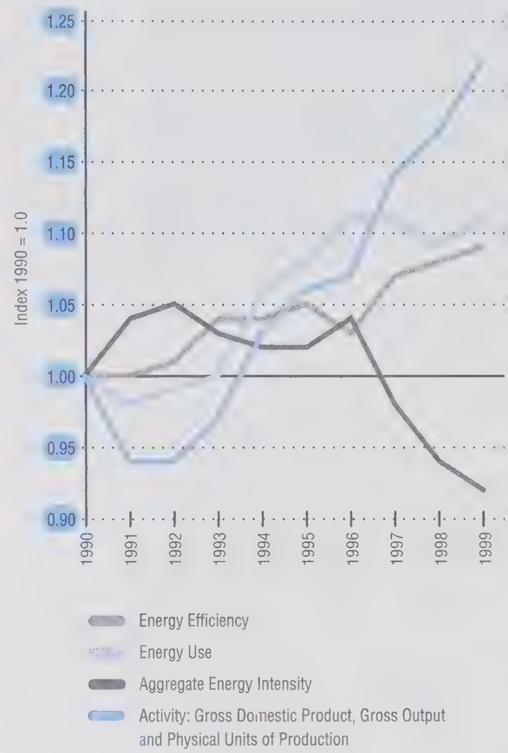
In 1999, natural gas represented 29.1 percent of energy use in the industrial sector. This was followed by electricity (25.6%); oil products (20.5%); other fuels, a category that includes biomass, waste fuels and steam (18.0%); coal, coke and coke oven gas (5.9%); and liquid petroleum gases and natural gas liquids (1.0%). This differs slightly from 1990 when natural gas accounted for 30.4 percent; electricity for 23.9 percent; oil products for 23.6 percent; other fuels for 14.7 percent; coal, coke and coke oven gas for 6.4 percent; and liquid petroleum gases and natural gas liquids for 1.0 percent.

...energy use increased by 11.4 percent while activity increased by 27.6 percent.

5.1 Evolution of Industrial Energy Use and Its Major Determinants

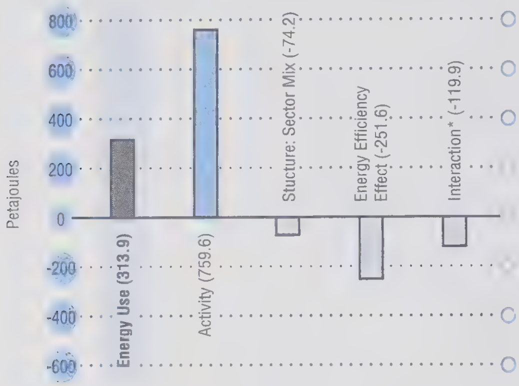
Figure 5.2 shows the trends in total industrial energy efficiency, energy use, aggregate energy intensity and activity from 1990 to 1999. Over this period, energy use increased by 11.4 percent while activity increased by 27.6 percent. Aggregate energy intensity (total energy to GDP ratio) in the industrial sector decreased by 8.4 percent between 1990 and 1999 while energy efficiency improved by 9.1 percent. The discrepancy between energy efficiency and aggregate energy intensity arises because aggregate energy intensity captures energy efficiency and structural changes. Also, the aggregate indicator is calculated using real GDP to represent activity while the energy efficiency indicator is calculated using a mix of physical units of output, gross output and real GDP. For more details regarding this activity indicator, see Section 5.3.

Figure 5.2 Industrial Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)



Changes in industrial energy use are attributed to three factors: changes in energy efficiency, changes in activity and changes in structure (the mix of economic activity among industries). The results of the factorization analysis for the industrial sector are shown in Figure 5.3.

Figure 5.3 Factors Influencing Growth in Industrial Energy Use, 1990–1999 (petajoules)



* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Industrial energy use rose by 313.9 petajoules between 1990 and 1999. The level of activity, as measured using a composite of physical units of production, gross output and GDP (see Appendix C in *Energy Efficiency Trends in Canada 1990 to 1998* for more details), was the only factor driving increased industrial energy use growth on average from 1990 to 1999 (increase of 759.6 petajoules). Over the 1990 to 1999 period, industrial activity increased by 27.6 percent. The sectors that contributed the most to the growth in activity were upstream mining, electrical and electronic, and motor vehicle parts and accessories.

The structure of the industrial sector also changed between 1990 and 1999, with a shift toward less energy-intensive industries. For example, the five most energy-intensive industries – the pulp, other non-metal mines, cement, petroleum refining and newsprint industries – together decreased their share of GDP by 0.6 percentage point. On the other hand, four of the least energy-intensive industries – electrical and electronic products, furniture and fixture, building board, and motor vehicle parts and accessories – increased their share of GDP by 8.2 percentage points. Overall, structural change led to a decrease in energy use of 74.2 petajoules.

Table 5.1 Summary of Trends in Energy Use and Activity in the Industrial Sector, 1990–1999 (percentage change)

	Energy Use	Activity
Total Industrial	11.4	21.7
Metal Mines*	-27.4	-22.5
Non-Metal Mines*	10.2	12.9
Upstream Mining	68.0	31.9
Construction	-24.7	-10.6
Forestry	91.8	0.2
Pulp*	13.4	36.4
Newsprint*	6.9	2.2
Paperboard*	37.0	44.1
Building Board*	138.2	220.5
Other Paper*	63.7	76.0
Primary Production of Aluminum*	41.4	52.5
Other Non-Ferrous Smelting and Refining	11.1	15.2
Petroleum Refining*	-13.6	8.1
Cement*	14.6	20.1
Industrial Inorganic Chemicals*	14.7	3.1
Industrial Organic Chemicals**	-18.8	4.1
Chemical Fertilizers and Fertilizer Materials*	90.3	9.3
Iron and Steel*	18.1	29.2
Food (excluding dairy)**	2.7	22.4
Dairy Products*	2.1	2.1
Beverage (excluding breweries)**	-18.9	27.0
Brewery Products*	-19.0	2.2
Tobacco Products**	-20.2	-3.4
Rubber Products*	20.0	97.9
Plastic Products**	34.5	64.7
Leather and Allied Products**	-3.2	-39.9
Primary Textile**	-9.9	22.7
Textile Products**	23.6	2.0
Clothing**	-1.5	-13.3
Wood**	80.0	29.8
Furniture and Fixture**	18.3	69.6
Printing, Publishing and Allied**	24.2	-22.9
Fabricated Metal Products**	36.3	14.5
Machinery**	11.0	10.1
Transportation Equipment**	24.7	80.3
Electrical and Electronic Products**	-7.2	181.6
Glass and Glass Products**	-3.8	67.4
Lime*	13.7	26.5
Plastic and Synthetic Resin*	42.2	56.5
Other Manufacturing n.e.c.	-57.7	19.4

* Physical units of production was used as the measure of activity for these sub-sectors.
**Gross output (in 1986 dollars) was used as the measure of the activity for these sub-sectors. For the remaining sub-sectors, GDP was used.

Energy efficiency in the industrial sector improved by 9.1 percent between 1990 and 1999.

Energy efficiency in the industrial sector improved by 9.1 percent between 1990 and 1999.

If only the energy efficiency of the sector changed over the period, while activity and structure remained constant, energy use would have decreased by 251.6 petajoules.

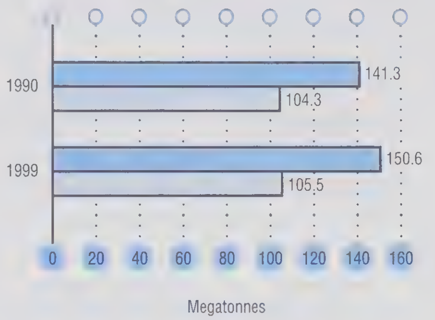
On an industry-by-industry basis, the most important improvements occurred in the electrical and electronic industry, peat industry, other manufacturing, and motor vehicle parts and accessories industries. However, some of these improvements were offset by a decline in energy efficiency in other sub-sectors such as leather and allied products, forestry, and chemical fertilizers and fertilizer materials.

It is important to note that this measure of energy efficiency is still influenced by factors other than energy efficiency. For example, variations in production methods, physical and value changes in products and weather can have a significant impact on energy consumption.

5.2 Trends in Greenhouse Gas Emissions from Industrial Energy Use

This year, GHG emissions are reported both including and excluding GHGs generated at electrical power generation facilities. This provides an indication of the magnitude and trends of both direct or "on-site" energy-related emissions and indirect energy-related emissions for each sector. Electricity-related emissions are calculated using an average emissions factor for all electricity produced in Canada. Figure 5.4 compares industrial GHG emissions with and without electricity-related emissions for 1990 and 1999.

Figure 5.4 Comparing Industrial GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

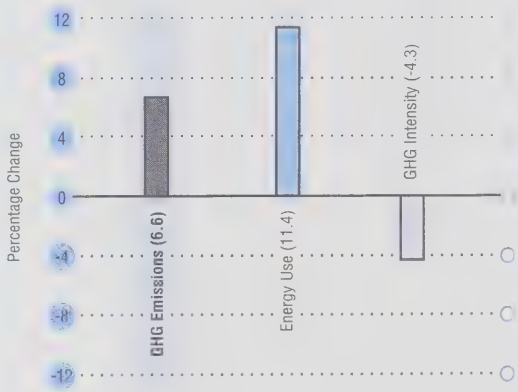


GHG emissions including electricity-related emissions were 35.5 and 42.7 percent higher than GHG emissions excluding electricity in 1990 and 1999 respectively.

Including Electricity-related GHG Emissions

Figure 5.5 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period including electricity-related emissions.

Figure 5.5 Factors Influencing Industrial Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)



The 4.3 percent decline in the GHG intensity of industrial energy use from 1990 to 1999 contributed to limiting the growth in GHG emissions to 6.6 percent. Without this decline in GHG intensity, emissions would have increased by 11.4 percent, or an additional 6.8 megatonnes.

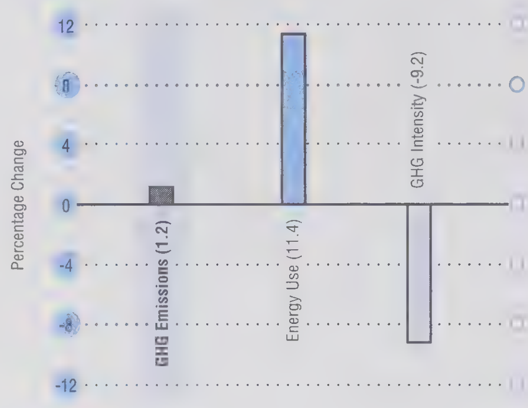
The downward trend in GHG intensity was due to changes in the mix of fuels used by industry. For instance, there was a reduction in the share of heavy fuel oil, coal, coke and coke oven gas used (down 3.3 percentage points) and an increased use of less GHG-intensive energy sources such as steam,[9] wood waste and pulping liquor (up 3.2 percentage points) and electricity (up 1.7 percentage points). The GHG intensity of electricity increased over the review period, although it still remains less GHG intensive relative to fossil-fuel-based sources of energy. If the change in the mix of fuels had not occurred, industrial GHG emissions from energy use would have been 7.0 megatonnes higher than actual levels.

The improvements in energy efficiency over the 1990 to 1999 period also significantly contributed to minimizing the increase in GHG emissions. Without the 9.1 percent improvement in energy efficiency, GHG emissions would have been 12.4 megatonnes higher in 1999 than they were, which would have made total 1999 industrial energy-related emissions 15.3 percent higher than 1990 levels.

Excluding Electricity-related GHG Emissions

Industrial GHG emissions excluding electricity-related emissions were 104.3 megatonnes in 1990 and increased to 105.5 megatonnes by 1999. Figure 5.6 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period excluding electricity-related emissions.

Figure 5.6 Factors Influencing Industrial Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)



The 9.2 percent decline in the GHG intensity of industrial energy use from 1990 to 1999 contributed to limiting the growth in GHG emissions to 1.2 percent. Without this decline in GHG intensity, emissions would have increased by 11.4 percent, or an additional 10.7 megatonnes.

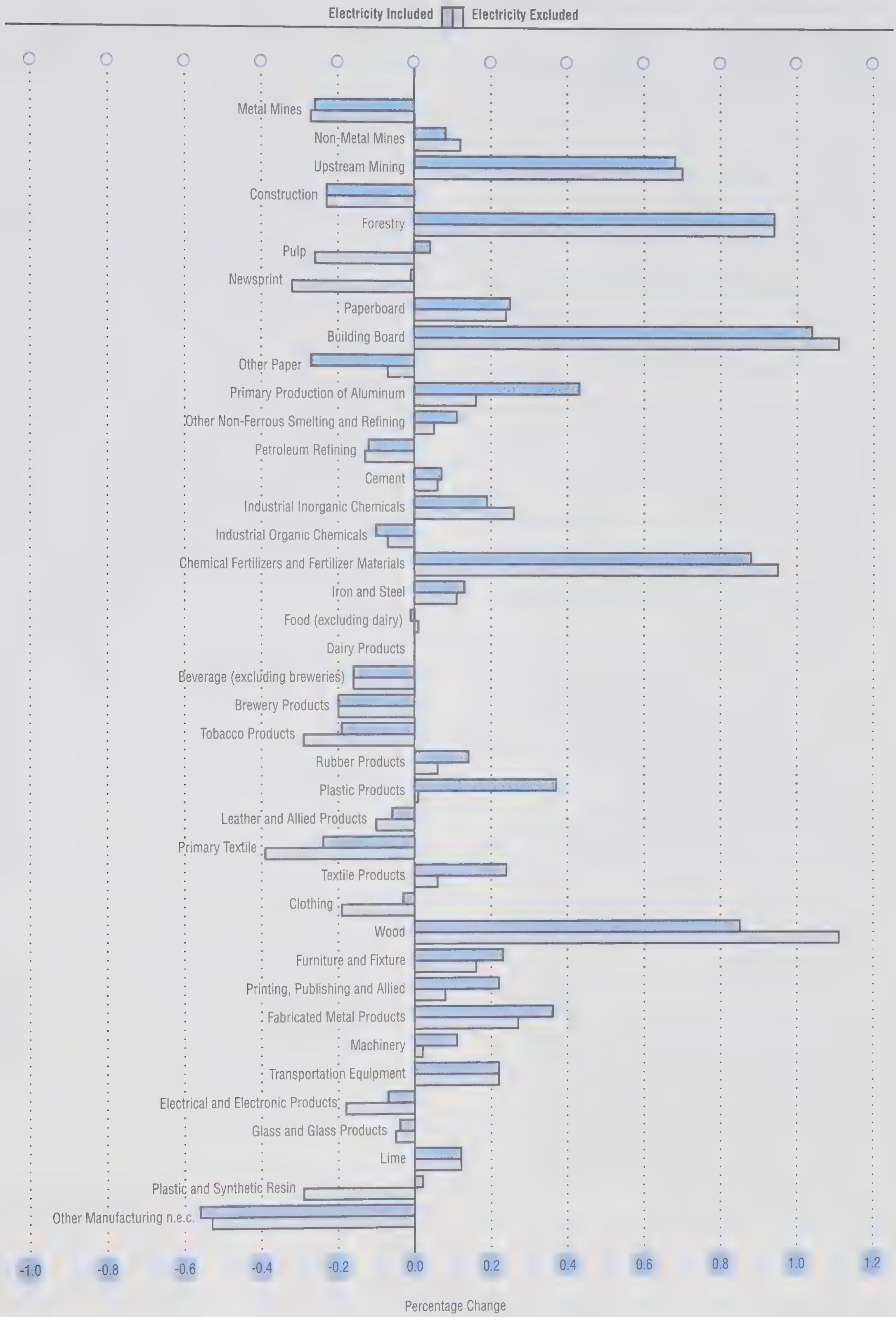
The improvements in energy efficiency over the 1990 to 1999 period significantly contributed to minimizing the increase in GHG emissions. Without the 9.1 percent improvement in energy efficiency, GHG emissions would have been 8.7 megatonnes higher in 1999 than they were, which would have made total 1999 industrial energy-related emissions 9.4 percent higher than 1990 levels.

Figure 5.7 shows the changes in GHG emissions, with and without electricity-related emissions by industry between 1990 and 1999.

The improvements in energy efficiency over the 1990 to 1999 period significantly contributed to minimizing the increase in GHG emissions.

9 Steam, like electricity, is produced using several different fuels of varying GHG intensity. It is assumed here that steam is GHG neutral to the user. The emissions associated with its production are assigned to the producers of the steam.

Figure 5.7 Change in GHG Emissions by Industry With and Without Electricity-related GHG Emissions, 1990–1999 (percentage change)



Five industrial sub-sectors – petroleum refining, iron and steel, upstream mining, newsprint and aluminum industries – contributed to more than half of the total industrial emissions in 1999 when electricity-related emissions are included. The share of emissions accounted for by these industries increased over the period, mainly as a result of the significant growth in emissions from the use of energy in the upstream mining industry.

Among the "other manufacturing" industries, those that contributed the most to emissions are food, wood, transportation equipment and other manufacturing, which accounted for more than 2 megatonnes each.

5.3 Methodology Changes and Data Situation

Several methodological improvements have been made in the industrial sector energy analysis since last year's report.

Industrial activity can be measured in two ways – as economic output or physical output. Measures of physical output are considered to be more meaningful and have been used by the OEE whenever possible. When these measures are not available, for example, when an industry's products are too diverse to allow the use of a single measure of physical output, gross output has been used. Likewise, when gross output is not available, GDP is used (gross output being more representative of physical units of production than GDP). These measures are used in conjunction with GDP to produce a composite measure of activity that is summable across industries and reflects growth in physical output. More detail regarding the calculation of industrial activity can be found in Appendix C, *Energy Efficiency Trends in Canada 1990 to 1998*.

In the last report, the factorization analysis was based on 40 industrial sub-sectors. In this report, the factorization analysis has been expanded to cover 53 sub-sectors. The metal mines, non-metal mines, food, wood and transportation equipment industries presented in last year's report are now split into their various sub-sectors. This increased disaggregation allows for a more accurate examination of the accumulated effects of shifts in the composition of the industrial sector and of industry-specific energy efficiency improvements. The increase in the number of industries analyzed is the result of work initiated by the OEE and undertaken by the Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC) in collaboration with the Canadian Industry Program for Energy Conservation (CIPEC) and Statistics Canada.

Chapter 6 Transportation Sector

Definition: The transportation sector in Canada includes activities related to passenger, freight and off-road transportation.

Non-commercial airline aviation and off-road transportation, although included in total transportation energy use, are not included in the factorization analysis of transportation energy use.

Highlights

- Over the 1990 to 1999 period, transportation energy use (E) increased by 20.3 percent, or 380.5 petajoules. Energy use in the passenger sub-sector increased by 13.5 percent (157.2 petajoules), while the freight sub-sector rose by 30.6 percent (201.5 petajoules).
- The growth in transportation energy use was influenced by changes in energy efficiency, activity and structure. These three factors had the following impacts:
  - Energy efficiency (EE) improved by 3.9 and 12.0 percent over the 1990 to 1999 period for the passenger and freight sub-sectors respectively. Had all other factors remained constant and only energy efficiency changed, transportation energy use would have decreased by 44.1 petajoules for passenger transportation and 78.9 petajoules for freight transportation.
  - Transportation activity (A) increased by 13.3 and 32.7 percent over the 1990 to 1999 period for the passenger and freight sub-sectors respectively. Had all other factors remained constant and only activity changed, transportation energy use would have increased by 150.0 and 215.3 petajoules for the passenger and freight sub-sectors respectively.
  - Changes in structure (S) or changes in the mix of vehicles used increased energy use. Had all other factors remained constant and only the mix of vehicles changed, energy use would have increased by 46.6 petajoules for passenger transportation and 91.7 petajoules for freight transportation.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 19.6 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
  - Had only energy use changed over the period, GHG emissions would have been 20.3 percent above 1990 levels.
  - The GHG intensity of transportation energy use (GHG/E) decreased by 0.5 percent, indicating a greater use of energy sources with a lower GHG content. This improvement helped offset the impact of increased energy use.
- Without the improvements in energy efficiency, passenger transportation GHG emissions would have been 3.1 megatonnes higher than they were in 1999, which would have made 1999 emissions for that sub-sector 16.3 percent higher than 1990 levels. Likewise, GHG emissions in the freight sub-sector would have been 5.8 megatonnes higher than they were in 1999, which would have made 1999 emissions for that sub-sector 42.3 percent higher than 1990 levels.

The Barometers – Transportation Sector

The Energy Use Barometer – Passenger Transportation

The Energy Use Barometer – Freight Transportation

The Emissions Barometer Including Electricity-related GHGs

Transportation energy use in 1999 was 2258.4 petajoules, accounting for 28.7 percent of secondary energy demand in Canada. GHG emissions from transportation energy use totalled 161.6 megatonnes of carbon dioxide (CO_2) equivalent, or about 35.7 percent of GHG emissions from secondary energy use. Of this amount, 155.0 megatonnes (about 96.0%) were emissions of CO_2 while the remaining 4.0 percent were emissions of methane (CH_4) and nitrous oxide (N_2O).

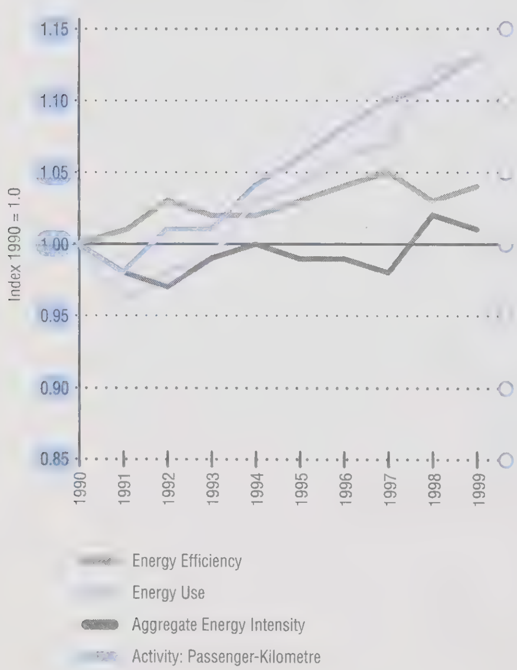
Passenger transportation accounted for 58.6 percent of the sector's energy in 1999, followed by freight transportation at 38.1 percent and off-road transportation at 3.3 percent.[10] Due to its relatively small share of total transportation energy use and lack of comparable data, off-road transportation is not included in the OEE's factorization analysis. Similarly, non-commercial airlines lack comparable activity data and are excluded from this analysis. Passenger and freight transportation energy use are decomposed below to demonstrate the impact of changes in energy efficiency, activity and structure on energy use in these sub-sectors.

10 Off-road transportation includes only transportation-related gasoline. Other sector-specific off-road energy use (e.g. agricultural) is included in its respective sector.

6.1 Evolution of Passenger Transportation Energy Use and Its Major Determinants

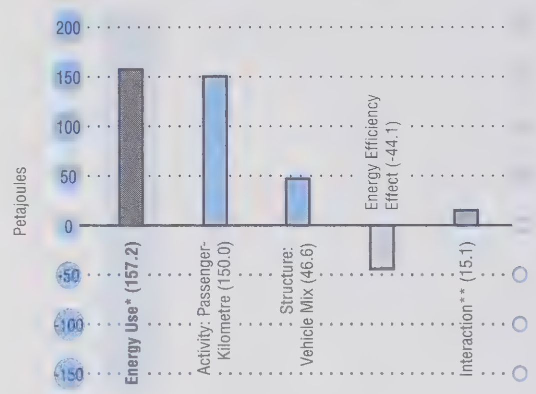
Passenger transportation energy use in 1999 was 1323.0 petajoules. Figure 6.1 depicts the trends in total passenger transportation energy efficiency, energy use, aggregate energy intensity and activity from 1990 to 1999. Over this period, energy use increased by 13.5 percent while activity (passenger-kilometres travelled) rose by 13.3 percent. Aggregate energy intensity (total energy to passenger-kilometres) ratio in the passenger transportation sector increased by 0.1 percent between 1990 and 1999, while energy efficiency improved by 3.9 percent. The discrepancy between energy efficiency and aggregate energy intensity arises because aggregate energy intensity captures changes in energy efficiency and structure.

Figure 6.1 Passenger Transportation Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)



Changes in passenger transportation energy use are attributed to three factors: changes in energy efficiency, changes in activity and changes in structure (changes in the mix of vehicles used). The results of the factorization analysis for the passenger transportation sector are shown in Figure 6.2.

Figure 6.2 Factors Influencing Growth in Passenger Transportation Energy Use, 1990–1999 (petajoules)



* The factorization excludes non-commercial airline aviation and off-road transportation.

** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Passenger transportation energy use rose by 157.2 petajoules between 1990 and 1999. The level of activity had the largest impact on the changes in energy use (increase of 150.0 petajoules). Over the 1990 to 1999 period, approximately 68 billion more passenger-kilometres were travelled in Canada.

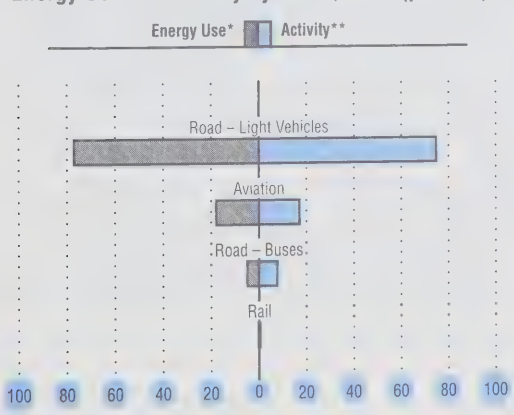
The structure (mix of vehicles) of transportation energy use also changed between 1990 and 1999, leading to an increase in energy use of 46.6 petajoules. This is explained by an increased use of light trucks for passenger transportation.

Most of the energy efficiency improvements occurred in the road segment, particularly for cars, light trucks and vans.

The only factor offsetting the increase in energy use was the change in energy efficiency (decrease of 44.1 petajoules). Most of the energy efficiency improvements occurred in the road segment, particularly for cars, light trucks and vans. The improvements resulted from factors such as technological changes to the load-reduction technologies and drivetrain. Improvements in load reduction technologies include reduced weight and wind resistance, and better performing tires that reduce tire resistance to road pavement. Drivetrain improvements include transmission changes (e.g. increased number of gears, electronic overdrive), improved lubricants that reduce friction, and accessory enhancements such as electric cooling fans replacing belt-driven fans. Engine upgrades, another facet of the drivetrain, improve fuel efficiency and performance through enhanced electronic controls, reduced internal friction and better valve controls.

In 1999, light vehicles accounted for 77.0 percent of the passenger sub-sector's energy use and 74.7 percent of activity, measured in passenger-kilometres, as shown in Figure 6.3. Total aviation accounted for 18.0 percent of passenger transportation energy use and 17.2 percent of activity. Buses accounted for most of the remaining energy use and activity in the sub-sector.

Figure 6.3 Distribution of Passenger Transportation Energy Use and Activity by Mode, 1999 (percent)

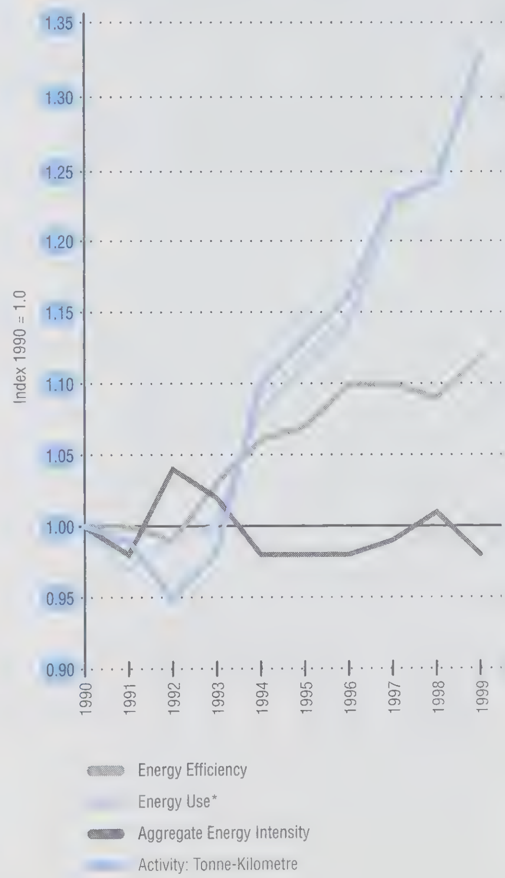


* Includes non-commercial airline aviation.
** Measured in passenger-kilometres; excludes non-commercial airline aviation.

6.2 Evolution of Freight Transportation Energy Use and Its Major Determinants

Freight transportation energy use in 1999 was 860.1 petajoules. Figure 6.4 depicts the trends in total freight transportation energy efficiency, energy use, aggregate energy intensity and activity from 1990 to 1999. Over this period, energy use increased by 30.6 percent while activity (tonne-kilometres moved) increased by 32.7 percent. Aggregate energy intensity (total energy to tonne-kilometres ratio) in the freight transportation sector decreased by 1.6 percent between 1990 and 1999 while energy efficiency improved by 12.0 percent.

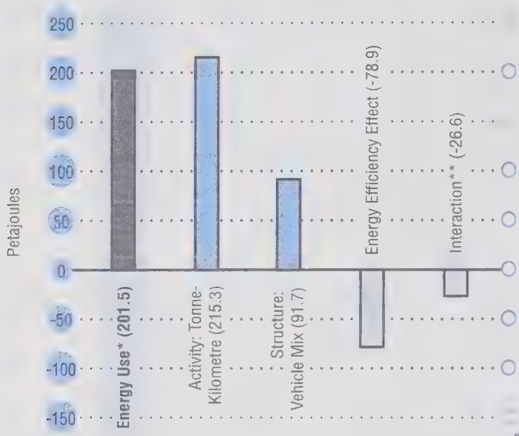
Figure 6.4 Freight Transportation Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)



* The factorization excludes non-commercial airline aviation and off-road transportation.

Changes in freight transportation energy use are attributed to three factors: changes in energy efficiency, changes in activity and changes in structure (changes in the mix of vehicles used). The results of the factorization analysis for the freight transportation sector are shown in Figure 6.5.

Figure 6.5 Factors Influencing Growth in Freight Transportation Energy Use, 1990–1999 (petajoules)



* The factorization excludes non-commercial airline aviation and off-road transportation.
** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Freight transportation energy use rose by 201.5 petajoules between 1990 and 1999. The level of activity had the largest impact (215.3 petajoules) on the changes in energy use. In 1999 approximately 177 billion more tonne-kilometres were moved in Canada compared to 1990.

The structure (mix of vehicles) of transportation energy use also changed between 1990 and 1999, leading to an increase in energy use (91.7 petajoules) in the sub-sector. This is explained by the fact that a greater share of freight was moved by trucks. As a result, the trucking industry's share of freight transportation energy use increased.

The only factor offsetting the increase in energy use was the change in energy efficiency (78.9 petajoules). Most of the improvement in energy efficiency occurred in the truck and rail segments. Heavy trucks, with a 45.9-petajoule improvement, contributed the most to the increase in energy efficiency in the freight sub-sector. The trucking industry has achieved efficiency improvements by consolidating loads (maximizing the use of the available capacity), increasing backhaul movements (reducing the number of kilometres travelled without freight loads), and improving its practices (vehicle maintenance, vehicle specification and drivers' skills). Efficiency improvements in rail have been realized as the industry rationalized and integrated its operations.

Heavy trucks, with a 45.9-petajoule improvement, contributed the most to the increase in energy efficiency in the freight sub-sector.

6.3 Trends in Greenhouse Gas Emissions from Transportation Energy Use

This year, GHG emissions are being reported both including and excluding GHGs generated at electrical power generation facilities for all sectors, except for the transportation sector because of its relatively small use of electricity (0.1% of total transportation energy use or 0.2 megatonnes of CO_2 equivalent). Thus, the GHG emission estimates below include electricity-related emissions.

Total energy-related transportation GHG emissions were 161.6 megatonnes in 1999, 19.6 percent higher than 1990 levels. Of the total transportation GHG emissions, passenger transportation produced 57.8 percent (93.4 megatonnes of CO_2 equivalent) and freight transportation 38.9 percent (62.9 megatonnes of CO_2 equivalent). The remaining emissions were a result of off-road transportation energy use.

Energy efficiency improved 3.9 and 12.0 percent respectively in the passenger and freight sub-sectors.

Figure 6.6 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period.

Figure 6.6 Factors Influencing Growth in Transportation Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

The 0.5 percent decline in the GHG intensity of transportation energy use from 1990 to 1999 contributed to limiting the growth in GHG emissions to 19.6 percent. Without this decline in GHG intensity, emissions would have increased to 20.3 percent above 1990 levels, or an additional 0.9 megatonnes.

The downward trend in GHG intensity was due to improvements in the GHG intensity of gasoline, natural gas and aviation turbo fuel which offset the impact of fuel shifting toward more GHG-intensive fuels such as diesel. In 1999, gasoline accounted for 57.3 percent of total energy use in the sector, a decline of 2.4 percentage points from 1990. During the same period, diesel's share of total energy used increased to 27.8 percent, an increase of 2.8 percentage points. Aviation turbo fuel accounted for 10.4 percent of total transportation energy use in 1999.

The improvements in energy efficiency over the 1990 to 1999 period also significantly contributed to minimizing the increase in GHG emissions. Energy efficiency improved 3.9 and 12.0 percent respectively in the passenger and freight sub-sectors. Without these improvements, transportation GHG emissions would have been 3.1 megatonnes higher than they were in 1999 for the passenger sub-sector and 5.8 megatonnes more than the 1999 level for the freight sub-sector, making total 1999 transportation energy-related emissions 26.1 percent higher than 1990 levels.

6.4 Methodology Changes and Data Situation

For this year's report, the factorization methodology for both the passenger and freight transportation energy use was performed at a more disaggregated level. In the past, the road segment of the passenger sub-sector was represented by the general categories of light vehicles and buses. These general categories pooled more disaggregated data: light vehicles comprised small and large cars, light trucks and motorcycles; buses included school buses, inter-city buses and urban transit vehicles. The new factorization approach for the passenger road segment considers the contribution to energy use of each of the disaggregated vehicle types separately. Similarly, the freight sub-sector has now been disaggregated to consider the contributions of light, medium and heavy trucks separately. These improvements provide better estimations of the impact of structural changes on each sub-sector of transportation energy use.

Chapter 7 Agriculture Sector

Definition: The agriculture sector in Canada includes all types of farms, including livestock, field crops, grain and oilseed farms. The data in this chapter are related to energy used for farm production and include energy use by establishments engaged in agricultural activities and in providing services to agriculture. It does not include the personal energy use of farmers.

Highlights

- Over the 1990 to 1999 period, agricultural energy use (E) increased by 15.4 percent or 30.8 petajoules.
- The growth in energy use was influenced by changes in aggregate energy intensity and activity. These factors had the following impacts:
  - Aggregate energy intensity (E/A) improved by 7.0 percent over the 1990 to 1999 period. Had activity remained constant and only aggregate energy intensity changed, agricultural energy use would have decreased by 14.0 petajoules.
  - Agricultural activity (A) increased by 24.2 percent. Had aggregate energy intensity remained constant and only activity changed, agricultural energy use would have increased by 48.1 petajoules.
- Greenhouse gas (GHG) emissions resulting from energy use (including electricity-related emissions) increased by 18.2 percent from 1990 to 1999. This growth is the result of changes in energy use and the GHG intensity of the energy used:
  - Had only energy use changed over the period, GHG emissions would have been 15.4 percent above 1990 levels.
  - The GHG intensity of agricultural energy use (GHG/E) increased by 2.0 percent, indicating a move toward a greater use of energy sources with a higher GHG content.
- Without the improvements in aggregate energy intensity, agricultural GHG emissions would have been 1.2 megatonnes higher in 1999 than they were, making 1999 emissions 26.7 percent higher than 1990 levels.

The Barometers – Agriculture Sector

The Energy Use Barometer

The Emissions Barometer
Including Electricity-related GHGs

The Emissions Barometer
Excluding Electricity-related GHGs

Agricultural energy use in 1999 was 229.9 petajoules, accounting for 2.9 percent of secondary energy demand in Canada. GHG emissions from agricultural energy use totalled 16.2 megatonnes of carbon dioxide (CO_2) equivalent, or about 3.6 percent of GHG emissions from secondary energy use. Of this amount, 15.1 megatonnes (about 93.2%) were emissions of CO_2 while the remaining 6.8 percent were emissions of methane (CH_4) and nitrous oxide (N_2O).

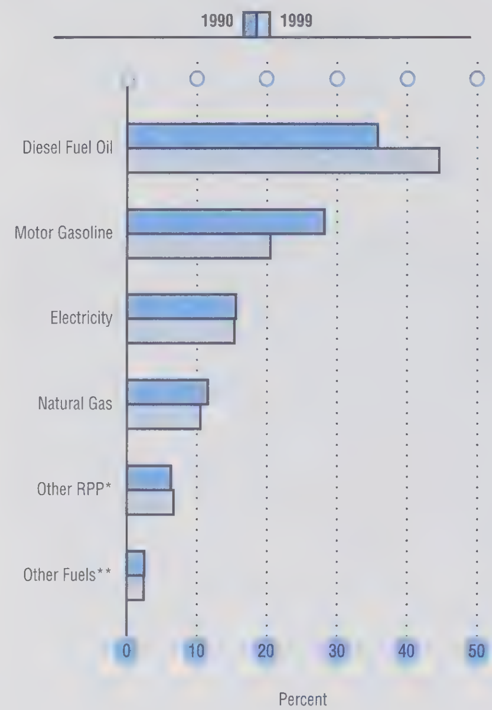
7.1 Evolution of Agricultural Energy Use and Its Major Determinants

Figure 7.1 depicts the trends in total agricultural energy use, aggregate energy intensity and activity from 1990 to 1999. Over this period, energy use increased by 15.4 percent while activity increased by 24.2 percent. Aggregate energy intensity (total energy to GDP ratio) in the agricultural sector decreased by 7.0 percent. In the agriculture sector, aggregate energy intensity is influenced by factors such as the mix of agricultural production (i.e. structure), weather conditions, the technology used and changes in agricultural practices. Energy efficiency trends are not reported for the agricultural sector due to a lack of sufficiently disaggregated data. The OEE is continually working to improve the agricultural energy database.

Figure 7.1 Agricultural Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Motive fuels (motor gasoline and diesel) were the dominant energy requirement and represented 65.2 percent of total energy use in the agriculture sector in 1999. Most of the growth in energy consumption during the review period was a result of increased demand for diesel. Figure 7.2 shows that gasoline's share of energy use declined by 7.6 percentage points between 1990 and 1999, while diesel's share increased by about 8.8 percentage points.

Figure 7.2 Agricultural Energy Fuel Shares, 1990 and 1999 (percent)

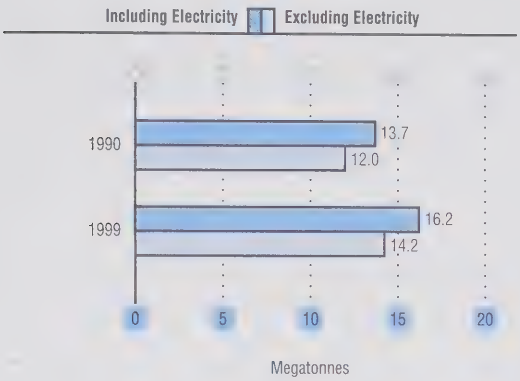


* Refined petroleum products include kerosene, light fuel oil and heavy fuel oil.
** Other fuels include propane and steam.

7.2 Trends in Greenhouse Gas Emissions from Agricultural Energy Use

This year, GHG emissions are reported both including and excluding GHGs generated at electrical power generation facilities. This provides an indication of the magnitude and trends of both direct or "on-site" energy-related emissions and indirect energy-related emissions for each sector. Electricity-related emissions are calculated using an average emissions factor for all electricity produced in Canada. Figure 7.3 compares agricultural GHG emissions with and without electricity-related emissions for 1990 and 1999.

Figure 7.3 Comparing Agricultural GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)



GHG emissions including electricity-related emissions were 14.2 and 14.1 percent higher than GHG emissions excluding electricity in 1990 and 1999 respectively.

Including Electricity-related GHG Emissions

Figure 7.4 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period including electricity-related emissions.

Figure 7.4 Factors Influencing Agricultural Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

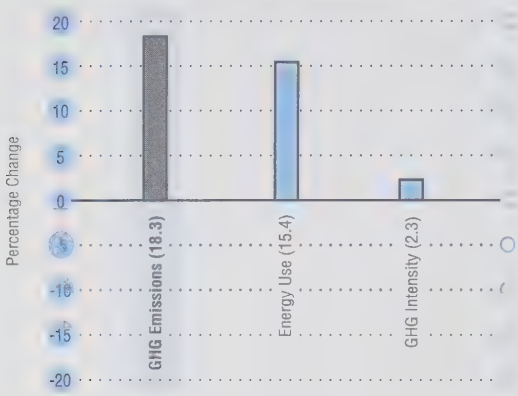
The 2.0 percent increase in the GHG intensity of agricultural energy use from 1990 to 1999 contributed to the 18.2 percent growth in GHG emissions. Without this growth in GHG intensity, emissions would have increased by only 15.4 percent.

The upward trend in GHG intensity of energy use was due to changes in the mix of fuels used, specifically an increase in diesel's share of total energy use, which increased from 35.9 percent in 1990 to 44.7 percent in 1999. Also, the GHG intensity of electricity increased over the review period, although electricity is still less GHG intensive relative to purely fossil-fuel-based sources of energy. If the change in the mix of fuels had not occurred, GHG emissions from energy use would have been 0.3 megatonnes lower than actual levels.

Excluding Electricity-related GHG Emissions

Agricultural GHG emissions excluding electricity-related emissions were 12.0 megatonnes in 1990 and increased to 14.2 megatonnes by 1999. Figure 7.5 summarizes the growth in GHG emissions, energy use and GHG intensity of energy use over the 1990 to 1999 period excluding electricity-related emissions.

Figure 7.5 Factors Influencing Agricultural Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)



The 2.3 percent increase in the GHG intensity of agricultural energy use from 1990 to 1999 contributed to the growth in GHG emissions, to 18.3 percent. Without this increase in GHG intensity, emissions would have increased by 15.4 percent.

Appendix A Data Presented in This Report

Figure A-1.2: The OEE Energy Efficiency Index, 1990–1999 (index 1990 = 1.0)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
OEE Energy Efficiency Index	1.00	1.01	1.03	1.04	1.04	1.05	1.04	1.06	1.07	1.08

Source:

Natural Resources Canada, Office of Energy Efficiency, *Energy Efficiency Trends in Canada*, Sectoral compilation.

Figure A-2.1: Secondary Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.01	1.03	1.04	1.04	1.05	1.04	1.06	1.07	1.08
Energy Use	1.00	0.98	1.00	1.02	1.06	1.07	1.11	1.11	1.09	1.12
Aggregate Energy Intensity	1.00	1.00	1.01	1.00	1.00	1.00	1.01	0.98	0.92	0.91
Activity	1.00	0.98	0.99	1.01	1.06	1.08	1.09	1.14	1.18	1.24

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990-1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *National Reference Forecast*, Ottawa, November 2000.

Figure A-2.2: Comparing Secondary Energy-related GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

	1990	1999
GHG Emissions Including Electricity	407.4	452.4
GHG Emissions Excluding Electricity	320.4	352.4

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990-1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-3.1: Residential Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.05	1.08	1.07	1.06	1.10	1.07	1.11	1.13	1.13
Energy Use	1.00	0.98	1.01	1.04	1.06	1.04	1.11	1.06	0.98	1.01
Aggregate Energy Intensity	1.00	0.96	0.96	0.98	0.98	0.95	1.00	0.93	0.84	0.86
Activity: Households and Floor Space	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days Below 18.0°C*, Toronto, 1990–1999.

Statistics Canada, *Household Facilities and Equipment, 1990–1997*, Ottawa, October 1990–October 1997 [Cat. 64-202].

Natural Resources Canada, *Survey of Household Energy Use*, 1993 and 1997.

Statistics Canada, *Survey of Household Spending in 1998*, Ottawa, October 2000 [Cat. 62M0004XCB].

Statistics Canada, *Survey of Household Spending in 1999*, Ottawa, December 2000 [Cat. 62F0041].

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.2: Factors Influencing Growth in Residential Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use	17.31
Activity: Households or Floor Space	240.88
Weather	-35.98
Structure: End-Use Mix	16.89
Energy Efficiency Effect	-171.76
Interaction*	-32.71

* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days below 18.0°C*, Toronto, 1990–1999.

Statistics Canada, *Household Facilities and Equipment, 1990-1997*, Ottawa, October 1990–October 1997 [Cat. 64-202].

Statistics Canada, *Survey of Household Spending in 1998*, Ottawa, October 2000 [Cat. 62M0004XCB].

Statistics Canada, *Survey of Household Spending in 1999*, Ottawa, December 2000 [Cat. 62F0041].

Natural Resources Canada, *Survey of Household Energy Use*, 1993 and 1997.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.3: Distribution of Residential Energy Use by End Use, 1999 (percent)

End Uses	1999
Space Cooling	0.75
Water Heating	21.55
Appliances	14.02
Space Heating	59.26
Lighting	4.42

Sources:

Statistics Canada, *Household Facilities and Equipment, 1990–1997*, Ottawa, October 1990–October 1997 [Cat. 64-202].

Statistics Canada, *Survey of Household Spending in 1998*, Ottawa, October 2000 [Cat. 62M0004XCB].

Statistics Canada, *Survey of Household Spending in 1999*, Ottawa, December 2000 [Cat. 62F0041].

Natural Resources Canada, *Survey of Household Energy Use*, 1993 and 1997.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.4: Factors Influencing Growth in Residential Space Heating Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use	-19.43
Activity: Floor Space	158.00
Weather	-35.98
Energy Efficiency Effect	-120.54
Interaction*	-20.91

* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days below 18.0°C*, Toronto, 1990–1999.

Statistics Canada, *Household Facilities and Equipment, 1990–1997*, Ottawa, October 1990–October 1997 [Cat. 64-202].

Statistics Canada, *Survey of Household Spending in 1998*, Ottawa, October 2000 [Cat. 62M0004XCB].

Statistics Canada, *Survey of Household Spending in 1999*, Ottawa, December 2000 [Cat. 62F0041].

Natural Resources Canada, *Survey of Household Energy Use*, 1993 and 1997.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.5: Factors Influencing Growth in Residential Appliance Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use	0.41
Activity: Households	29.75
Appliance Penetration Market	11.21
Energy Efficiency Effect	-34.85
Interaction*	-5.70

* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Sources:

Statistics Canada, *Household Facilities and Equipment, 1990–1997*, Ottawa, October 1990–October 1997 [Cat. 64-202].

Statistics Canada, *Survey of Household Spending in 1998*, Ottawa. December 1999 [Cat. 62F0041].

Statistics Canada, *Survey of Household Spending in 1999*, Ottawa. December 2000 [Cat. 62F0041].

Natural Resources Canada, *EnerGuide Directories, 1990–1999*, Ottawa.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.6: Comparing Residential GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

	1990	1999
GHG Emissions Including Electricity	69.7	69.9
GHG Emissions Excluding Electricity	43.5	42.5

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.7: Factors Influencing Residential Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	0.29
Energy Use	1.31
GHG Intensity	-1.01

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-3.8: Factors Influencing Residential Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	-2.30
Energy Use	1.31
GHG Intensity	-3.57

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Residential End-Use Model*, Ottawa, February 2001.

Figure A-4.1: Distribution of Commercial Energy Use and Activity by Building Type, 1999 (percent)

Building Types	Energy Use	Activity
Retail	25.08	22.04
Office	23.92	28.08
School	13.38	14.59
Health	11.41	6.84
Hotel and Restaurant	9.10	5.60
Recreation	6.38	6.42
Warehouse	5.30	10.04
Other Institutional*	4.25	4.69
Religious	1.18	1.69

* Laboratory, research centre, library, museum

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *Historical Estimates of Commercial Floor Space, 1998 Database Update*, Ottawa, January 2001.

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.2: Commercial Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.02	1.02	1.02	1.03	1.01	1.01	0.99	1.02	1.02
Energy Use*	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13
Aggregate Energy Intensity	1.00	0.99	0.99	1.01	0.99	1.02	1.03	1.03	0.96	0.98
Activity: Floor Space	1.00	1.03	1.05	1.07	1.08	1.09	1.10	1.12	1.14	1.16

* Energy use includes street lighting but the factorization excludes street lighting.

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days above 18.0°C*, Toronto, 1990-1999.

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days below 18.0°C*, Toronto, 1990-1999.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990-1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *Historical Estimates of Commercial Floor Space, 1998 Database Update*, Ottawa, January 2001.

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.3: Factors Influencing Growth in Commercial Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use*	116.59
Activity: Floor Space	136.05
Weather	-2.78
Structure: Building Type	1.28
Energy Efficiency Effect	-13.38
Interaction**	-3.01

* Energy use includes street lighting but the factorization excludes street lighting.

** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days Above 18.0°C*, Toronto, 1990–1999.

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days Below 18.0°C*, Toronto, 1990–1999.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *Historical Estimates of Commercial Floor Space, 1998 Database Update*, Ottawa, January 2001.

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.4: Distribution of Commercial Energy Use by End Use, 1999 (percent)

End Uses	1999
Space Heating	50.31
Lighting*	15.11
Auxiliary Motor	12.75
Water Heating	7.96
Auxiliary Equipment	7.42
Space Cooling	6.46

* Energy use excludes street lighting.

Sources:

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days Above 18.0°C*, Toronto, 1990–1999.

Environment Canada, *Atmospheric Environment Service, Monthly Summary of Degree-Days Below 18.0°C*, Toronto, 1990–1999.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *Historical Estimates of Commercial Floor Space, 1998 Database Update*, Ottawa, January 2001.

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.5: Comparing Commercial GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

	1990	1999
GHG Emissions Including Electricity	47.6	54.1
GHG Emissions Excluding Electricity	25.7	28.8

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999, Ottawa*, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.6: Factors Influencing Commercial Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	13.66
Energy Use*	13.45
GHG Intensity	0.18

* Energy use includes street lighting.

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-4.7: Factors Influencing Commercial Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	12.06
Energy Use*	13.45
GHG Intensity	-1.35

* Energy use includes street lighting.

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Natural Resources Canada, *Commercial End-Use Model*, Ottawa, February 2001.

Figure A-5.1: Distribution of Energy Use and Activity (GDP) by Industrial Sub-sector, 1999 (percent)

Sectors	Energy Use 1999	Activity 1999
Pulp	13.20	0.91
Upstream Mining	11.52	10.72
Petroleum Refining	9.43	1.29
Newsprint	9.19	1.65
Iron and Steel	8.44	1.64
Other Paper	5.51	1.13
Primary Production of Aluminum	5.24	1.13
Industrial Organic Chemicals	3.06	0.89
Industrial Inorganic Chemicals	2.77	0.56
Paperboard	2.59	0.79
Other Non-Ferrous Smelting and Refining	2.52	0.59
Food (excluding dairy)	2.46	5.32
Other Manufacturing n.e.c.	2.41	8.19
Cement	2.22	0.21
Metal Mines	2.22	2.09
Wood	2.19	3.53
Transportation Equipment	2.13	9.17
Chemical Fertilizers and Fertilizer Materials	2.08	0.38
Construction	1.64	16.07
Non-Metal Mines	1.42	0.59
Fabricated Metal Products	1.22	4.17
Plastic and Synthetic Resin	0.74	0.85
Electrical and Electronic Products	0.55	10.77
Lime	0.53	N.A.
Plastic Products	0.53	1.70
Forestry	0.48	1.79
Machinery	0.46	2.10
Primary Textile	0.42	0.66
Dairy Products	0.40	0.74
Glass and Glass Products	0.39	0.54
Rubber Products	0.36	1.01
Printing, Publishing and Allied	0.35	2.36
Textile Products	0.27	0.59
Beverage (excluding breweries)	0.24	0.77
Furniture and Fixture	0.20	1.48
Building Board	0.20	1.27
Brewery Products	0.19	0.72
Clothing	0.17	1.21
Leather and Allied Products	0.04	0.13
Tobacco Products	0.03	0.31

Sources:

Informetrica Limited, *National Reference Forecast*, Ottawa, November 2000.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Figure A-5.2: Industrial Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.00	1.01	1.04	1.04	1.05	1.03	1.07	1.08	1.09
Energy Use	1.00	0.98	0.99	1.00	1.06	1.08	1.11	1.11	1.09	1.11
Aggregate Energy Intensity	1.00	1.04	1.05	1.03	1.02	1.02	1.04	0.98	0.94	0.92
Activity: GDP, GO and physical units	1.00	0.94	0.94	0.97	1.03	1.06	1.07	1.14	1.17	1.22

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Informetrica Limited, *National Reference Forecast*, Ottawa, November 2000.

Figure A-5.3: Factors Influencing Growth in Industrial Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use	313.88
Activity	759.60
Structure: Sector Mix	-74.20
Energy Efficiency Effect	-251.64
Interaction*	-119.87

* For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998.*

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Informetrica Limited, *National Reference Forecast*, Ottawa, November 2000.

Figure A-5.4: Comparing Industrial GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

	1990	1999
GHG Emissions Including Electricity	141.3	150.6
GHG Emissions Excluding Electricity	104.3	105.5

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-5.5: Factors Influencing Industrial Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	6.58
Energy Use	11.39
GHG Intensity	-4.31

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions,* Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-5.6: Factors Influencing Industrial Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	1.15
Energy Use	11.39
GHG Intensity	-9.21

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-5.7: Change in GHG Emissions by Industry With and Without Electricity-related GHG Emissions, 1990–1999 (percentage change)

	GHG Emissions	
Sub-Industries	Electricity Included	Electricity Excluded
Metal Mines	-0.26	-0.27
Non-Metal Mines	0.08	0.12
Upstream Mining	0.68	0.70
Construction	-0.23	-0.23
Forestry	0.94	0.94
Pulp	0.04	-0.26
Newsprint	-0.01	-0.32
Paperboard	0.25	0.24
Building Board	1.04	1.11
Other Paper	-0.27	-0.07
Primary Production of Aluminum	0.43	0.16
Other Non-Ferrous Smelting and Refining	0.11	0.05
Petroleum Refining	-0.12	-0.13
Cement	0.07	0.06
Industrial Inorganic Chemicals	0.19	0.26
Industrial Organic Chemicals	-0.10	-0.07
Chemical Fertilizers and Fertilizer Materials	0.88	0.95
Iron and Steel	0.13	0.11
Food (excluding dairy)	-0.01	0.01
Dairy Products	0.00	0.00
Beverage (excluding breweries)	-0.16	-0.16
Brewery Products	-0.20	-0.20
Tobacco Products	-0.19	-0.29
Rubber Products	0.14	0.06
Plastic Products	0.37	0.01
Leather and Allied Products	-0.06	-0.10
Primary Textile	-0.24	-0.39
Textile Products	0.24	0.06
Clothing	-0.03	-0.19
Wood	0.85	1.11
Furniture and Fixture	0.23	0.16
Printing, Publishing and Allied	0.22	0.08
Fabricated Metal Products	0.36	0.27
Machinery	0.11	0.02
Transportation Equipment	0.22	0.22
Electrical and Electronic Products	-0.07	-0.18
Glass and Glass Products	-0.04	-0.05
Lime	0.12	0.12
Plastic and Synthetic Resin	0.02	-0.29
Other Manufacturing n.e.c.	-0.56	-0.53

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Canadian Industrial Energy End-Use Data and Analysis Centre, *Development of Energy Intensity Indicators for Canadian Industry 1990 to 1999*, Simon Fraser University, February 2001.

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-6.1: Passenger Transportation Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.01	1.03	1.02	1.02	1.03	1.04	1.05	1.03	1.04
Energy Use	1.00	0.96	0.98	0.99	1.03	1.04	1.06	1.07	1.12	1.13
Aggregate Energy Intensity	1.00	0.98	0.97	0.99	1.00	0.99	0.99	0.98	1.02	1.01
Activity: Passenger-Kilometre	1.00	0.98	1.01	1.01	1.04	1.06	1.08	1.10	1.11	1.13

Sources:

Royal Commission on National Passenger Transportation, *Directions: the Final Report of the Royal Commission on National Passenger Transportation*, Ottawa, 1992; 2.

Statistics Canada, *Air Carrier Operations in Canada 1990–1994*, Ottawa, 1991–1995; 21(1)–25(4) [Cat. 51-002].

Statistics Canada, *Aviation Statistics Centre: Service Bulletin, Ottawa, 1990–1996*; 22(1)–28(12) [Cat. 51-004].

Statistics Canada, *Canadian Civil Aviation 1995–1998*, Ottawa, 1996-2000 [Cat. 51-206]; Natural Resources Canada, 1999 estimates.

Statistics Canada, *Passenger Bus and Urban Transit Statistics 1990–1998*. February 1993–December 1999 [Cat. 53-215]; Natural Resources Canada, 1999 estimates.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Statistics Canada, *Rail in Canada 1990–1998*, Ottawa, July 1992–April 2000 [Cat. 52-216]; Natural Resources Canada, 1999 estimates.

Natural Resources Canada, *Transportation Energy Demand Model*, Ottawa, February 2001.

Figure A-6.2: Factors Influencing Growth in Passenger Transportation Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use*	157.15
Activity: Passenger-Kilometre	149.96
Structure: Vehicle Mix	46.64
Energy Efficiency Effect	-44.11
Interaction**	15.13

* The factorization excludes non-commercial airline aviation and off-road transportation.

** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998*.

Sources:

Royal Commission on National Passenger Transportation. *Directions: the Final Report of the Royal Commission on National Passenger Transportation*, Ottawa, 1992; 2.

Statistics Canada, *Air Carrier Operations in Canada 1990–1994*, Ottawa, 1991–1995; 21(1)–25(4) [Cat. 51-002].

Statistics Canada. *Aviation Statistics Centre: Service Bulletin*, Ottawa, 1990–1996; 22(1)–28(12) [Cat. 51-004].

Statistics Canada, *Canadian Civil Aviation 1995–1998*, Ottawa, 1996–2000 [Cat. 51-206]; Natural Resources Canada, 1999 estimates.

Statistics Canada, *Passenger Bus and Urban Transit Statistics 1990–1998*. February 1993–December 1999 [Cat. 53-215]; Natural Resources Canada, 1999 estimates.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Statistics Canada, *Rail in Canada 1990–1998*, Ottawa, July 1992–April 2000 [Cat. 52-216]; Natural Resources Canada, 1999 estimates.

Natural Resources Canada, *Transportation Energy Demand Model*, Ottawa, February 2001.

Figure A-6.3: Distribution of Passenger Transportation Energy Use and Activity by Mode, 1999 (percent)

Modes	Energy Use*	Activity**
Road – Light Vehicles	76.96	74.70
Aviation	17.95	17.15
Road – Buses	4.91	7.88
Rail	0.17	0.27

* Includes non-commercial airline aviation

** Measured in passenger-kilometres, excludes non-commercial airline aviation

Sources:

Royal Commission on National Passenger Transportation, *Directions: the Final Report of the Royal Commission on National Passenger Transportation*, Ottawa, 1992; 2.

Statistics Canada, *Air Carrier Operations in Canada 1990–1994*, Ottawa, 1991–1995; 21(1)–25(4) [Cat. 51-002].

Statistics Canada, *Aviation Statistics Centre: Service Bulletin*, Ottawa, 1990–1996; 22(1)–28(12) [Cat. 51-004].

Statistics Canada, *Canadian Civil Aviation 1995–1998*, Ottawa, 1996–2000 [Cat. 51-206]; Natural Resources Canada, 1999 estimates.

Statistics Canada, *Passenger Bus and Urban Transit Statistics 1990–1998*. February 1993–December 1999 [Cat. 53-215]; Natural Resources Canada, 1999 estimates.

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Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, 1999, Ottawa, January 2001; 24(4) [Cat. 57-003].

Statistics Canada, *Rail in Canada 1990–1998*, Ottawa, July 1992–April 2000 [Cat. 52-216]; Natural Resources Canada, 1999 estimates.

Natural Resources Canada, *Transportation Energy Demand Model*, Ottawa, February 2001.

Figure A-6.4: Freight Transportation Energy Efficiency, Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Efficiency	1.00	1.00	0.99	1.03	1.06	1.07	1.10	1.10	1.09	1.12
Energy Use*	1.00	0.97	0.99	1.00	1.08	1.11	1.14	1.22	1.25	1.31
Aggregate Energy Intensity	1.00	0.98	1.04	1.02	0.98	0.98	0.98	0.99	1.01	0.98
Activity: Tonne-Kilometre	1.00	0.99	0.95	0.98	1.10	1.13	1.16	1.23	1.24	1.33

* The factorization excludes non-commercial airline aviation and off-road transportation.

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Statistics Canada, *Rail in Canada 1990–1998*, Ottawa, July 1992–April 2000 [Cat. 52-216]; Natural Resources Canada, 1999 estimates.

Transport Canada, *Surface and Marine Statistics and Forecast Division*, Personal Communication, December 1999.

Statistics Canada, *Trucking in Canada 1990*, Ottawa, February 1993 [Cat. 53-222].

Statistics Canada, *Trucking in Canada 1999*, Ottawa, February 2001 [Cat. 53-222].

Natural Resources Canada, *Transportation Energy Demand Model*, Ottawa, February 2001.

Figure A-6.5: Factors Influencing Growth in Freight Transportation Energy Use, 1990–1999 (petajoules)

	1990–1999
Energy Use*	201.51
Activity: Tonne-Kilometre	215.34
Structure: Vehicle Mix	91.70
Energy Efficiency Effect	-78.92
Interaction**	-26.61

* The factorization excludes non-commercial airline aviation and off-road transportation.

** For an explanation of this term, see the section called "Note on Interaction Terms" in Appendix C of *Energy Efficiency Trends in Canada 1990 to 1998*.

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Statistics Canada, *Rail in Canada 1990–1998*, Ottawa, July 1992–April 2000 [Cat. 52-216]; Natural Resources Canada, 1999 estimates.

Transport Canada, *Surface and Marine Statistics and Forecast Division*, Personal Communication, October 2000.

Statistics Canada, *Trucking in Canada 1990*, Ottawa, February 1993 [Cat. 53-222].

Statistics Canada, *Trucking in Canada 1999*, Ottawa, February 2001 [Cat. 53-222].

Figure A-6.6: Factors Influencing Growth in Transportation Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	19.62
Energy Use	20.26
GHG Intensity	-0.54

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-7.1: Agricultural Energy Use, Aggregate Energy Intensity and Activity, 1990–1999 (index 1990 = 1.0)

Factors	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Use	1.00	0.98	0.99	1.00	0.98	1.05	1.12	1.16	1.13	1.15
Aggregate Energy Intensity	1.00	0.99	1.07	1.01	0.95	1.00	1.02	1.06	0.98	0.93
Activity: Gross Domestic Product	1.00	0.99	0.93	0.99	1.03	1.06	1.10	1.09	1.15	1.24

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Informetrica Limited, *National Reference Forecast*, Ottawa, November 2000.

Figure A-7.2: Agricultural Energy Fuel Shares, 1990 and 1999 (percent)

Fuel Types	1990	1999
Diesel Fuel Oil	35.91	44.67
Motor Gasoline	28.15	20.57
Electricity	15.61	15.33
Natural Gas	11.63	10.48
Other RPP*	6.19	6.56
Other Fuels**	2.50	2.39

* Refined petroleum products include kerosene, light fuel oil and heavy fuel oil.

** Other fuels include: propane and steam.

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Figure A-7.3: Comparing Agricultural GHG Emissions Including and Excluding Electricity-related GHG Emissions, 1990 and 1999 (megatonnes)

	1990	1999
GHG Emissions Including Electricity	13.7	16.2
GHG Emissions Excluding Electricity	12.0	14.2

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-7.4: Factors Influencing Agricultural Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	18.25
Energy Use	15.45
GHG Intensity	2.03

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Figure A-7.5: Factors Influencing Agricultural Energy-related GHG Emissions Excluding Electricity-related GHG Emissions, 1990–1999 (percentage change)

	1990–1999
GHG Emissions	18.33
Energy Use	15.45
GHG Intensity	2.33

Sources:

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1990–1997 revisions*, Ottawa, February 2000 (CANSIM).

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1998 revisions*, Ottawa, January 2001.

Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada, 1999*, Ottawa, January 2001; 24(4) [Cat. 57-003].

Environment Canada, *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removal with Trends*, Ottawa, April 1999 [EN49-8/5-9].

Appendix B Methodology

This appendix describes the key elements of the methodology that were used in this study to analyze secondary energy end use and energy efficiency trends in Canada.

An energy index is used to isolate the impact of energy efficiency, structural influences and changes in activity levels on secondary energy consumption. The index is based on the following equation:

$$E = A\sum_{i} \frac{A_i}{A} \frac{E_i}{A_i}$$

This equation demonstrates that the energy for a sector is equal to the total activity in that sector times the sum of the share of activity in each sub-sector times the energy intensity for that sub-sector. The energy intensity of each sub-sector net of the impact of changes in the weather and the structure of the market is used to approximate the change in the average energy efficiency of the equipment in each end-use sector. By indexing this equation to 1990, and holding all factors but one constant at their base-year values, the influence of that one factor is identified. This methodology, based on a Laspeyres index, has been used extensively in international comparisons of energy use.

The OEE energy efficiency index was developed to provide a single index of secondary energy efficiency, adjusted for structural changes in the economy. This index is based on the changes in energy consumption because of energy efficiency that is derived in the factorization of secondary energy use outlined above. The index has been simplified this year and is represented by the following equation:

$$OEE = 1 + \left(1 - \sum_{j} \frac{E_{j0}}{E_0} I_j\right)$$

Where I_j is the energy use index for a sector when all factors are held constant except sub-sector energy intensity and the base-year energy consumption index. Thus, the OEE index is an index of changes in energy used due to changes in energy efficiency. When energy efficiency improves, there is an increase in the OEE index; inversely, when energy efficiency deteriorates, the OEE index decreases.

Appendix C Reconciliation of Data on Energy Use Found in This Report

with Statistics Canada's *Quarterly Report on Energy Supply-Demand in Canada – 1999*

Introduction

The bulk of the energy use data that are presented in this report are taken from Statistics Canada's *Quarterly Report on Energy Supply-Demand in Canada* (QRESD). Several sectoral reallocations and data improvements that were made in previous reports were no longer required in this report since NRCan initiated and funded a major review of QRESD for 1990 to 1999. However, for the purpose of the analysis undertaken in this study, some modifications to the original Statistics Canada data were still required and are documented in Table C.1.

The following describes modifications to QRESD sector definitions in each end-use sector for the purpose of this report.

Residential Sector

One modification was made to the QRESD definition of the residential sector: the addition of fuel wood use. The inclusion of fuel wood use is a net addition to residential energy demand as reported in the QRESD. Residential fuel wood use is estimated using NRCan's *Residential End-Use Model.*

Commercial Sector

One modification was made to the QRESD definition of the commercial sector: the reallocation of commercial and public administration motive fuels to the transportation sector in order to include only stationary energy use in the commercial sector. All of the data required for this reallocation are found in the QRESD and described in Table C.1.

In addition, although it does not affect total commercial electricity demand, street lighting electricity consumption is now identified separately as reported by Statistics Canada's *Electric Power Statistics* (Cat. No. 57–202).

Industrial Sector

Three modifications were made to the QRESD definition of the industrial sector: the reallocation of producer consumption by the petroleum refining and mining industries to the industrial sector, the addition of solid wood waste and spent pulping liquor and the addition of waste fuels used in the cement industry.

The first reallocation relates to producer consumption by the petroleum refining and mining industries. Statistics Canada classifies the use of non-purchased petroleum products by the petroleum refining and mining industries as producer consumption. In this report, this energy use has been reallocated to the industrial sector (petroleum refining and mining industries) as it is an end-use consumption.

Data on consumption of solid wood waste and spent pulping liquor is included in a supplementary table in the QRESD but not in the QRESD's energy supply-demand balance. For the purpose of this report, the energy demand of the industrial sector is modified to include spent pulping liquor and wood waste consumption.

Waste fuels used in the cement industry are not included in the QRESD's energy supply-demand balance. In this report, the energy demand of the industrial sector includes waste fuels as reported in CIEEDAC's publication *Development of Energy Intensity Indicators for Canadian Industry, 1990 to 1999.*

Transportation Sector

Two modifications were made to the QRESD definition of the transportation sector: the reallocation of commercial motive fuels from the commercial and public administration sector and the reallocation of pipeline fuel use to producer consumption.

Commercial and public administration motive fuels have been reallocated from the commercial sector to the transportation sector to include only stationary energy use in the commercial sector. The reallocation of pipeline fuel use to producer consumption is done in order to include only vehicle energy use in the transportation sector. Since pipeline fuel is fuel that is used in the distribution of energy to end-use markets, we have reallocated it to producer consumption and do not consider it end-use consumption.

Agriculture Sector

No modification.

Table C.1: Reconciliation of Data on Energy Use Found in This Report with Statistics Canada's *Quarterly Report on Energy Supply-Demand in Canada* – 1999

Sector	QRESD data	Fuel Wood	Commercial & Public Admin. Diesel	Commercial & Public Admin. Aviation Fuels	Commercial & Public Admin. Motor Gasoline	Pipeline Fuels	Solid Wood Waste & Pulping Liquor	Waste Fuels Used in Cement Industry	Reallocation of Producer Consumption by Refining and Mining Industries	Energy Efficiency Trends Data
Residential	1228	107								1335
Commercial	1190		-116	-29	-62					984
Industrial	2163						513	6	386	3069
Transportation	2313		116	29	62	-261				2258
Agriculture	230									230
Final Demand	7125	107	0	0	0	-261	513		386	7876
Non-Energy	825									825
Producer Consumption	1224					261			-386	1099
Net Supply	9174	107	0	0	0	0	513		0	9800
Conversion Losses*	1447									1447
Total Primary	10621	107	0	0	0	0	513	6	0	11247

Notes on Sources of Energy Use Data for Five End-Use Sectors:

Residential: Base data taken from QRESD (Table 1B, line 44) plus fuel wood use (estimated from NRCan's *Residential End-Use Model*).

Agriculture: Base data taken from QRESD (Table 1B, line 43).

Commercial: Base data taken from QRESD (line 45 plus line 46) less commercial and public administration motor gasoline (Table 1D, motor gasoline column, line 45 plus line 46) less commercial and public administration diesel (Table 1D, diesel column, line 45 plus line 46). less commercial and public administration aviation gasoline (Table 1D, aviation gasoline column, line 45 plus line 46) less commercial and public administration aviation turbo fuel (Table 1D, aviation turbo fuel column, line 45 plus line 46).

Transportation: Base data taken from QRESD (Table 1B, line 42) less pipeline fuels (Table 1B, natural gas plus electricity plus petroleum products columns, line 39) plus commercial and public administration motor gasoline (Table 1D, motor gasoline column, line 45 plus line 46) plus commercial and public administration diesel (Table 1D, diesel column, line 45 plus line 46) plus commercial and public administration aviation gasoline (Table 1D, aviation gasoline column, line 45 plus line 46) plus commercial and public administration aviation turbo fuel (Table 1D, aviation turbo fuel column, line 45 plus line 46).

Industrial: Base data taken from QRESD (Table 1B, line 31) plus solid wood waste and pulping liquor (Table 19) plus producer consumption by refinery and mining industries, industry of still gas, diesel, heavy fuel oil, light fuel oil, kerosene, petroleum coke and refinery LPG (Table 1D, still gas, diesel, heavy fuel oil, light fuel oil, kerosene, petroleum coke and refinery LPG columns, line 16) plus waste fuels used in the cement industry.

* Electricity conversion rates: hydro-electricity converted at rate of 3.6 megajoules per kilowatt-hour; nuclear electricity converted at rate of 11.564 megajoules per kilowatt-hour.

Appendix D Glossary of Terms

This glossary is divided into five sections: General, Residential Sector, Commercial Sector, Industrial Sector and Transportation Sector. The General section includes general terminology as well as terminology common to more than one sector.

General

Activity: Term used to characterize major drivers of energy use in a sector (e.g. number of households in the residential sector).

Calibration process: Process by which deviations between disaggregated and aggregated data are determined and rectified.

Canada's National Action Program on Climate Change (NAPCC): Sets strategic directions in pursuit of Canada's commitment to stabilize GHG emissions at 1990 levels by the year 2000 and provides guidance for actions beyond the year 2000. The NAPCC pursues sectoral and broad-based opportunities through the development of appropriate actions and measures by private and public jurisdictions, reviews progress, and makes adjustments as required.

Carbon dioxide: A compound of carbon and oxygen formed whenever carbon is burned. Chemical formula: CO_2. CO_2 is a colourless gas that absorbs infrared radiation mostly at wavelengths between 12 and 18 microns; it behaves as a one-way filter allowing incoming, visible light to pass through in one direction while preventing outgoing infrared radiation from passing in the opposite direction. The one-way filtering effect of CO_2 causes an excess of the infrared radiation to be trapped in the atmosphere; thus, the atmosphere acts as a greenhouse and has the potential to increase the surface temperature of the Earth.

Climate change: A change attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which, in addition to natural climate variability, is observed over comparable time periods.

Cooling Degree-Days: A measure of how hot a location was over a period of time relative to a base temperature. In this report, the base temperature is 18°C; the period of time is one year. The cooling degree-days for a single day is the difference between that day's average temperature and 18°C, if the daily average exceeds the base temperature. It is zero if the daily average is less than or equal to the base temperature. The cooling degree-days for a longer period of time is the sum of the daily cooling degree-days from the days in the period.

End use: Any specific activity that requires energy (e.g. refrigeration, space heating, water heating, manufacturing process, feedstocks).

Energy efficiency indicators: Indicators of how efficiently energy is used.

Energy intensity: The amount of energy use per unit of activity (examples of activity measures in this report are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production or constant dollar value of GDP by industry).

Energy source: Any substance that supplies heat or power (e.g. petroleum, natural gas, coal, renewable energy, and electricity, including the use of a fuel as a non-energy feedstock).

Factorization method: A method used to decompose changes in the total energy used in a sector over a certain period of time into changes in the overall demand for that sector's output, changes in the structural composition of the sector, and changes in the energy intensity of the individual sub-sectors contributing to the sector's output. The factorization method used in this report is the Laspeyre index.

Fossil fuel: Any naturally occurring organic fuel, such as petroleum, coal and natural gas.

Gigajoule: One gigajoule equals 1 x 10^9 joules. A joule is the international unit of energy – the energy produced by a power of one watt flowing for one second. There are 3.6 million joules in one kilowatt-hour.

Global warming: See Greenhouse gas.

Greenhouse gas: A greenhouse gas absorbs and radiates heat in the lower atmosphere that otherwise would be lost in space. The greenhouse effect is essential for life on Earth since it keeps average global temperatures high enough to support plant and animal growth. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_2O). By far the most abundant greenhouse gas is CO_2, accounting for 70 percent of the greenhouse effect (see Carbon dioxide).

Greenhouse gas intensity of energy: The amount of greenhouse gas emissions per unit of energy.

Gross Domestic Product (GDP): The total value of goods and services produced by the nation's economy before deduction of depreciation charges and other allowances for capital consumption, labour and property located in Canada. It includes the total output of goods and services by private consumers and government, gross private domestic capital investment, and net foreign trade. GDP figures are reported in real 1986 dollars.

Gross output: The total value of goods and services produced by an industry, a sum of the industry's shipments plus the change in value due to labour and capital investment.

Heating Degree-Days: A measure of how cold a location was over a period of time relative to a base temperature. In this report, the base temperature is 18°C; the period of time is one year. The heating degree-days for a single day is the difference between that day's average temperature and 18°C, if the daily average is below the base temperature. It is zero if the daily average exceeds or equals the base temperature. The heating degree-days for a longer period is the sum of daily heating degree-days for days in that period.

Interaction effect: In the factorization method, this is a weighted average of the change in intensity and structure variables.

Petajoule: One petajoule equals 1 x 10^{15} joules (see Gigajoule).

Petroleum: A naturally occurring mixture of predominantly hydrocarbons in the gaseous, liquid or solid phase.

Primary energy use: Represents the total requirements for all uses of energy, including energy used by the final consumer (see Secondary energy use), non-energy uses, intermediate uses of energy, energy in transforming one energy form to another (e.g. coal to electricity), and energy used by suppliers in providing energy to the market (e.g. pipeline fuel).

Secondary energy use: Energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

Sector: The broadest category for which energy consumption and intensity are considered within the Canadian economy (e.g. residential, agriculture, commercial, industrial and transportation).

Space cooling: Conditioning of room air for human comfort by a refrigeration unit (e.g. air conditioner or heat pump) or by circulating chilled water through a central-cooling or district-cooling system.

Space heating: The use of mechanical equipment to heat all or part of a building. Includes both the principal space-heating and supplementary space-heating equipment.

Structural change: As it affects energy efficiency, structural change is a change in the shares of activity accounted for by the energy-consuming sub-sectors within a sector. An example of structural change is a change in industry mix in the industrial sector.

Water heating: The use of energy to heat water for hot running water, as well as the use of energy to heat water on stoves and in auxiliary water-heating equipment for bathing, cleaning and other non-cooking applications.

Residential Sector

Apartment: This type of dwelling includes dwelling units in apartment blocks or apartment hotels; flats in duplexes or triplexes (i.e. where the division between dwelling units is horizontal); suites in structurally converted houses; living quarters located above or in the rear of stores, restaurants, garages or other business premises; janitors' quarters in schools, churches, warehouses, etc.; and private quarters for employees in hospitals or other types of institutions.

Appliances: Energy-consuming equipment used in the home for purposes other than air conditioning or centralized water heating. Includes cooking appliances (gas stoves, gas ovens, electric stoves, electric ovens, microwave ovens, and propane or gas grills); cooling appliances (evaporative coolers, attic fans, window or ceiling fans, portable or table fans); and refrigerators, freezers, clothes washers, electric dishwashers, electric clothes dryers, outdoor gas lights, electric dehumidifiers, personal computers, electric pumps for well water, black-and-white televisions, colour televisions, water bed heaters, swimming pools, swimming pool heaters, hot tubs, and spas.

Dwelling: A dwelling is defined as a structurally separate set of living premises with a private entrance from outside the building or from a common hallway or stairway inside. A private dwelling is one in which one person, a family or other small group of individuals may reside, such as a single house, apartment, etc.

Floor space (area): The area enclosed by exterior walls of a building, excluding parking areas, basements or other floors below ground level. It is measured in square metres.

Furnace: Space-heating equipment consisting of an enclosed chamber where fuel is burned or electrical resistance is used to heat air directly, without using steam or hot water. The warm air is for heating and is distributed throughout the house, typically by air ducts.

Heated living area: The area within a dwelling that is space heated.

Household: A person or a group of persons occupying one dwelling unit is defined as a household. The number of households will, therefore, be equal to the number of occupied dwellings. The person or persons occupying a private dwelling form a private household.

Household size: The number of persons per household.

Mobile home: A moveable dwelling designed and constructed to be transported (by road) on its own chassis to a site and placed on a temporary foundation such as blocks, posts or a prepared pad. It should be capable of being moved to a new location.

Single-attached home: Each half of a semi-detached (double) house and each section of a row or terrace is defined as a single-attached dwelling. A single dwelling attached to a non-residential structure also belongs to this category.

Single-detached home: This type of dwelling is commonly called a single house (i.e. a house containing one dwelling unit and completely separated on all sides from any other building or structure).

Commercial Sector

Floor space (area): The area enclosed by exterior walls of a building, including parking areas, basements, or other floors below ground level. It is measured in square metres.

Occupational density: The number of occupants per square metre of floor area.

Industrial Sector

Auxiliary equipment: Devices that supply energy services to the major process technologies during their operation and that are common to most industries. Auxiliary equipment falls into five categories: steam generation, lighting, heating, ventilation and air conditioning, and electric motors including pumps, fans, compressors and conveyors.

Building board: Compressed paper products used as sheeting, backing for furniture, tack boards, etc. It may be used as structural material in construction.

Coke: A hard, porous product made from baking bituminous coal in ovens at high temperatures.

Coke oven gas: Complex gas (containing hydrogen, methane, light oil, ammonia, pitch, tar and other minerals) released during coke production.

Inorganic chemicals industry: Sub-sector of the chemicals industry represented by SIC 3711. Examples of chemical commodities produced by this sector include caustic soda, sodium chlorate, oxygen, chlorine and sulphuric acid.

Organic chemicals industry: Sub-sector of the chemicals industry represented by SIC 3712. Examples of chemical commodities produced by this sector include ethylene, methyl alcohol, benzene, toluene and xylene.

Paperboard: Stiff paper product used primarily to make cartons and containers (cereal boxes, cracker boxes, etc.). It may be layered and used to make book covers and even furniture.

Spent pulping liquor: A substance primarily made up of lignin, other wood constituents, and chemicals that are by-products of the manufacture of chemical pulp. It can be burned in a boiler to produce steam or electricity through thermal generation.

Standard Industrial Classification (SIC): A classification system that categorizes establishments into groups with similar economic activities.

Waste fuels: A name applied to any number of energy sources outside of conventional fuels. It can include materials such as tires, municipal waste and landfill off-gases.

Transportation Sector

Gross vehicle weight (GVW): The weight of the empty vehicle plus the maximum anticipated load weight.

Heavy trucks: Trucks with a gross vehicle weight of more than or equal to 14 970 kilograms (33 001 pounds).

Large cars: Cars weighing more than or equal to 1182 kilograms (2601 pounds).

Light trucks: Trucks up to 3855 kilograms (8500 pounds) of gross vehicle weight.

Light vehicles: Cars, motorcycles, and light trucks, including vans.

Medium trucks: Trucks with a gross vehicle weight ranging from 3856 to 14 969 kilograms (8501 pounds to 33 000 pounds).

Passenger-kilometre: The transport of one passenger over a distance of one kilometre.

Small cars: Cars weighing up to 1181 kilograms (2600 pounds).

Tonne-kilometre: The transport of one tonne over a distance of one kilometre.

OEE

Energy Efficiency Trends in Canada 1990 to 1999 — *An Update*

Indicators of Energy Use, Energy Efficiency and Emissions — *July 2001*

Factors Influencing Growth in Secondary Energy Use, 1990–1999 (petajoules)

Sector	Energy Use 1990	1999	1999 less 1990 (5)	A	S	W	EE	I	Other
Residential	1317.6	1335.0	17.3	240.9	16.9	-36.0	-171.8	-32.7	NA
Commercial (1)	867.0	983.6	116.6	136.0	1.3	-2.8	-13.4	-3.0	-1.6
Industrial	2754.7	3068.5	313.9	759.6	-74.2	NA	-251.6	-119.9	NA
Transportation	1877.9	2258.4	380.5	365.3	138.3	NA	-123.0	-11.5	11.4
Passenger (2)	1165.8	1323.0	157.2	150.0	46.6	NA	-44.1	15.1	-10.5
Freight	658.6	860.1	201.5	215.3	91.7	NA	-78.9	-26.6	0.0
Off-Road Motor Gasoline (3)	53.4	75.3	21.8	NA	NA	NA	NA	NA	21.8
Agriculture (4)	199.2	229.9	30.8	NA	NA	NA	NA	NA	30.8
Total	**7016.4**	**7875.4**	**859.0**	**1501.8**	**82.3**	**-38.8**	**-559.8**	**-167.1**	**40.6**

Terms:
A: Activity Effect, **S**: Structure Effect, **W**: Weather Effect, **EE**: Energy Efficiency Effect, **I**: Interaction Effect

(1) The factorization excludes street lighting. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(2) The factorization was done excluding the non-airline (commercial/institutional and public administration) air sector. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(3) The factorization analysis was not done for off-road motor gasoline. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(4) The factorization analysis was not done for the agricultural sector. Chapter 7 shows an aggregate analysis of the sector. The change in energy use for this component from 1990 to 1999 is shown in the "Other" column.

(5) The change in energy use between 1990 and 1999 shown in this column and the sum of the activity, structure, weather, energy efficiency and interaction for passenger and freight transportation are slightly different because of the exclusion from the factorization analysis of the non-commercial airlines in passenger transportation. The transportation sector differences are reflected at the secondary energy use level; other differences are excluded from the factorization such as agriculture, off-road motor gasoline and street lighting, which are included under "Other" column.

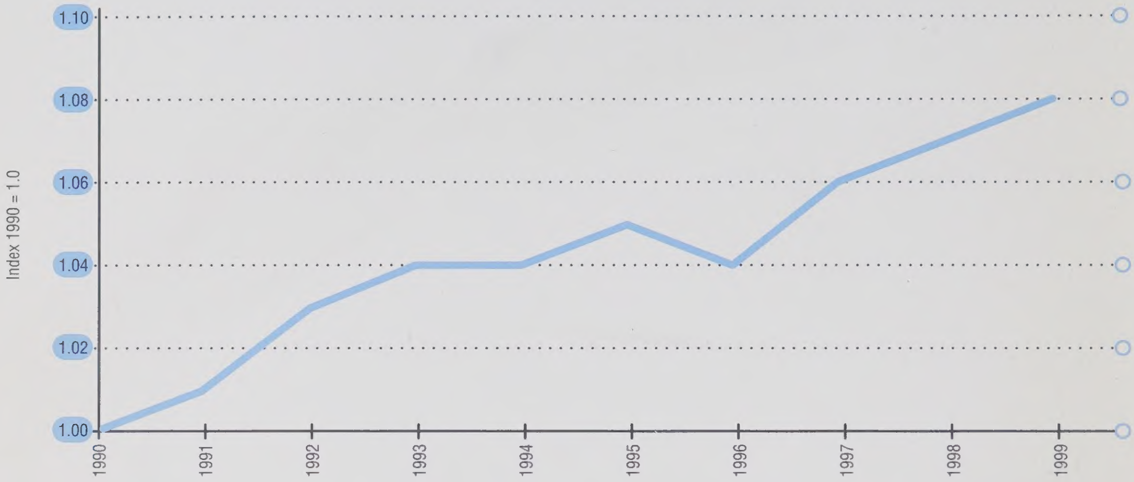
The change in energy use is explained by four factors. They are activity, structure, weather and energy efficiency. Activity represents the major drivers of energy use in a sector (e.g. floor area in the commercial sector). Structure corresponds to the change in the share of activity of each sub-sector within a sector (e.g. industry mix in the industrial sector). Weather accounts for the influence of the climate on energy use. Energy efficiency represents the effect of more efficient energy use on the total energy consumption. The total change in energy use is the sum of the four effects.

Natural Resources Canada — Ressources naturelles Canada
Office of Energy Efficiency — Office de l'efficacité énergétique

Canada

Sectoral energy efficiency variations are aggregated into a single index of secondary energy efficiency, the OEE index.

The OEE Energy Efficiency Index, 1990–1999 (index 1990 = 1.0)



The following table summarizes the changes in greenhouse gas emissions, energy use and greenhouse gas intensity of energy use from 1990 to 1999.

Factors Influencing Secondary Energy-related GHG Emissions Including Electricity-related GHG Emissions, 1990–1999

Sector	Greenhouse Gas Emissions (megatonnes)		Greenhouse Gas Emissions (percentage change)	Energy Use (percentage change)	Greenhouse Gas Intensity of Energy Use (percentage change)
	1990	1999			
Residential	69.7	69.9	0.3	1.3	-1.0
Commercial	47.6	54.1	13.7	13.4	0.2
Industrial	141.3	150.6	6.6	11.4	-4.3
Transportation	135.1	161.6	19.6	20.3	-0.5
Agriculture	13.7	16.2	18.2	15.4	2.0
Total	**407.4**	**452.4**	**11.0**	**12.2**	**-1.1**

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Cat. no. M27-01-1590E